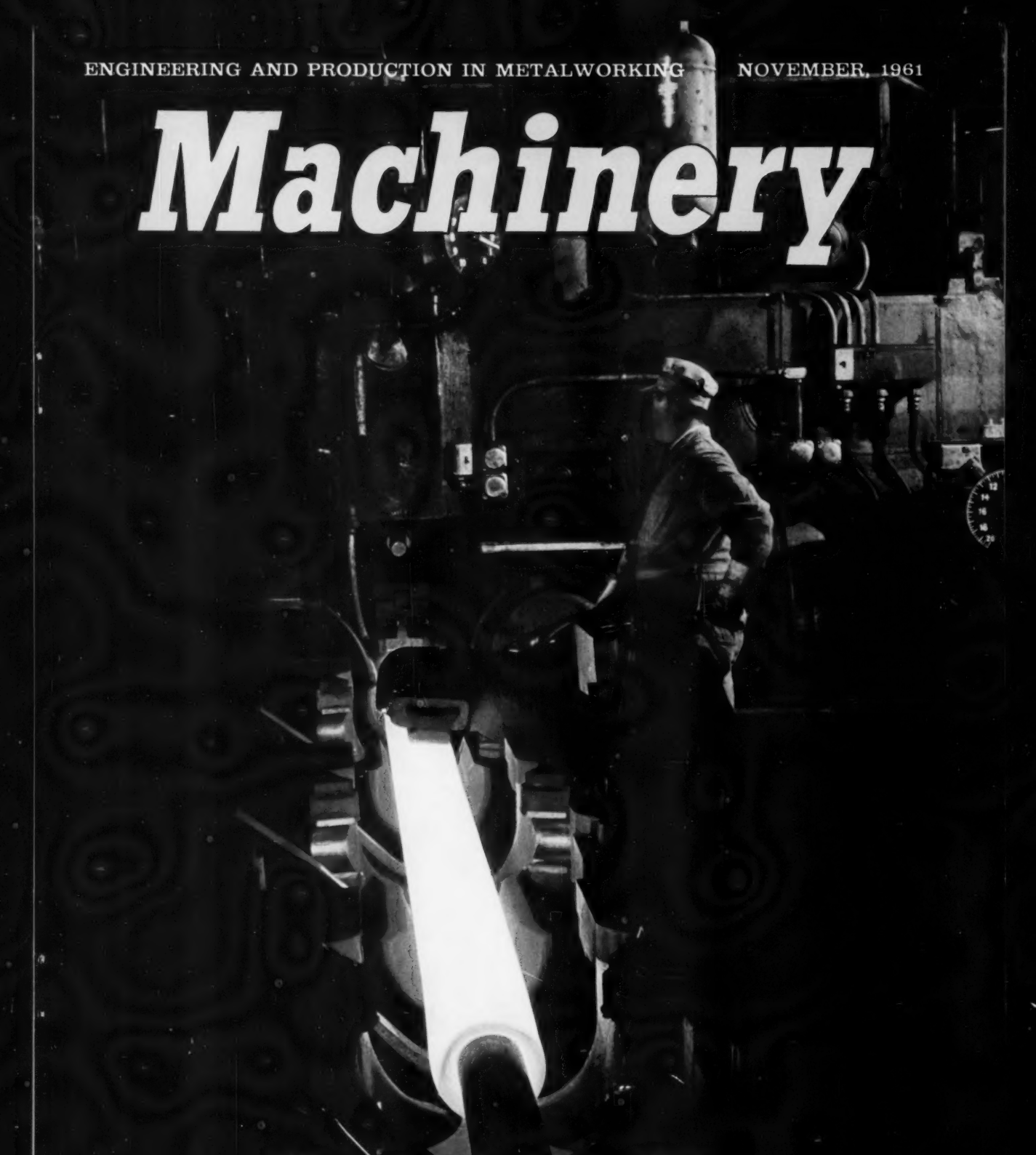
ENGINEERING AND PRODUCTION IN METALWORKING — NOVEMBER, 1961

Machinery



When only the best will do...

TIMKEN® FINE ALLOY STEEL

See Advertisement Page 51

THE NEW "A" BORE-MATICS

Completely new machine design from base to bridges for versatility, capacity and ease of maintenance.

by Albert A. Arbogast

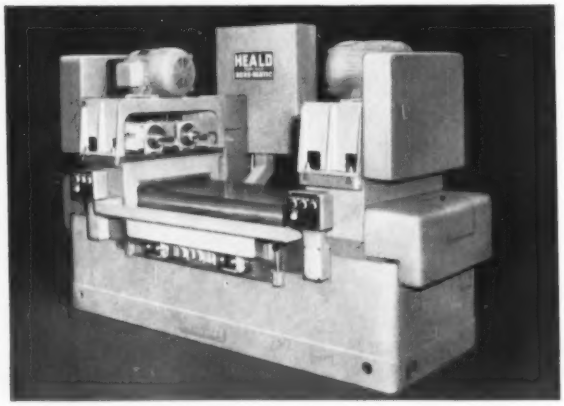
Manager, Bore-Matic Machine Division
The Heald Machine Company

What is the basic philosophy behind the new "A" series line of Bore-Matics? That's a good question—and a simple one to answer because the basic motivating factor was "simplicity" itself. For in almost every case the basic new design feature in this new Bore-Matic line makes them *easier* to set up, *easier* to change over, *easier* to operate and *easier* on service inspection. All this has been accomplished while still maintaining our continual trend toward higher standards of accuracy and precision.

Take the new machine bridges, for example. Within a given size of machine, bridges are removable and interchangeable. Furthermore if a user has a single-end version of a new "A" Bore-Matic he can readily convert it to a double-end unit by adding a second bridge, boringheads, drive, and associated cycle and hydraulic equipment.

Bridge pads and tee slots are provided at both ends of all machines in each of three size ranges. Bridge setback is infinitely adjustable within its range, too—permitting wider latitude for tooling and fixture design and minimum rapid traverse time. New bridge location has also substantially increased the workholding capacity of these standard machines.

Manifold hydraulic transfer plates and valves that used to be inside the base cavity are now mounted externally on a separate panel at the rear where they are more easily accessible—such a location also isolates a heat source from the machine base contributing to uniform precision throughout longest production runs.



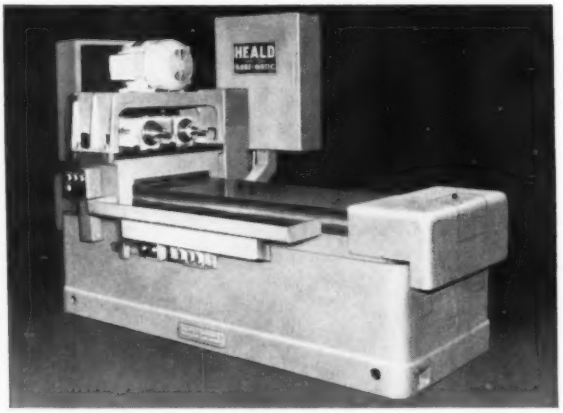
The hydraulic power unit has also been located separately from the base at the rear of the machine, for ease of access and elimination of thermal distortion.

The machine table is larger, heavier and travels on hardened and ground box type ways with hold downs—such construction assures maximum accuracy of table travel.

The new model Bore-Matics are now available in three basic "A" machine sizes—2, 3 & 4—each of which can be furnished as either single or double end machines.

Capacities of the new "A" series Bore-Matics are shown in the following table:

	222A	322A	422A
Width of Bridge	31"	34"	38"
Distance between Bridges (adj.)	16"-36"	24"-43"	30"-54"
Table travel	15" or 18"	20"	25"
Table Pad Dimension	14" x 55"	18" x 64"	24" x 80"



Above, Model 424A, single end version of the size 4 type Bore-Matic; bridge, heads, drive equipment, etc. on left end only.

At left, 422A, double end version of the size 4 type Bore-Matic; bridges, heads, drive equipment, etc. on both ends of machine.

It Pays to come to Heald

THE HEALD MACHINE COMPANY

Subsidiary of The Cincinnati Milling Machine Co.
Worcester 6, Massachusetts

NOVEMBER 1961

VOL. 68 NO. 3

Editor CHARLES O. HERB

Managing Editor
RAYMOND H. SPIOTTA

Associate Editors
FREEMAN C. DUSTON
HAROLD W. BREDIN
LAURENCE W. COLLINS, Jr.

Midwestern Editor CHARLES H. WICK
6712 Mark Court, Birmingham, Mich.

Materials Editor PAUL B. SCHUBERT

Published monthly by THE INDUSTRIAL PRESS. ROBERT B. LUCHARS, *President;* EDGAR A. BECKER, *Vice-President and Treasurer.* Editorial, Advertising and Circulation Offices: 93 Worth St., New York 13, N. Y. Telephone, CAnal 6-8120.

Business Manager
ARNOLD F. CARUSO

Advertising Representatives
WALTER E. ROBINSON
W. R. WASHINGTON
93 Worth St., New York 13, N. Y.
ROBERT J. LICK
313 E. 216th St., Cleveland 23, Ohio
EMMET J. O'CONNELL
228 N. LaSalle St., Chicago 1, Ill.
NORMAN O. WYNKOOP, Jr.
44 Highland Ave., Detroit 3, Mich.
G. C. SMITH
53 Garrison Road, Brookline, Mass.
DON HARWAY & CO.
336 N. Central Ave., Glendale 3, Calif.
RICHARD E. HOIERMAN
9006 Capri Drive, Dallas 18, Tex.
FRED W. SMITH
1201 Forest View Lane, Birmingham 9, Ala.

Subscription rates: United States and Canada, one year, $10; foreign countries, one year, $15; two years, $28. Single copies, $1.00; foreign, $1.50. Changes in address must be received by the first of the month to be effective for the next issue. Send old as well as new address. Copyright 1961 by THE INDUSTRIAL PRESS.

Accepted as controlled circulation publication at Bristol, Conn.

Great Britain
MACHINERY
National House, West St., Brighton 1, England
and
Clifton House, 83-117 Euston Road
London, N.W. 1, England

France
LA MACHINE MODERNE
15, Rue Bleue, Paris-IX*, France

BPA NEP

Machinery

THE MONTHLY MAGAZINE OF ENGINEERING AND PRODUCTION IN THE MANUFACTURE OF METAL PRODUCTS

SHOP PRACTICE

Precision Bearing Technology Takes a Giant Step ..... Raymond H. Spiotta 77
Machining Long Panels for DC-8 Jetliners ..... C. F. Wallace 93
Out-of-Roundness of Machined Parts ..... Earl E. Lindberg 102
Recent Advances in High-Energy-Rate Forming 132

MACHINE AND TOOL DESIGN

Better Pipe Welds at 12 Miles per Hour ..... Laurence W. Collins, Jr. 88
Tester Pinpoints Errors in Machine Tool Operation ... Laurence W. Collins, Jr. 96
Multiple Holder for Necking and Chamfering Cuts ..... Roger Isetts 128
Lathe Tracer Attachment Turns Quill Taper and Grooves .... Donald A. Baker 129
Lathe Attachment Hobs Worm-Wheel Segment with Fractional Number of Teeth ..... Ernest E. Novel 130
Shaft-Diameter Nomograph—1 and 2 (Data Sheet) 145

MANAGEMENT PROBLEMS AND EVENTS

Why??? ..... Charles O. Herb 75
Opening of New Facilities Marks Sixtieth Anniversary 108
Bethlehem Steel Dedicates Homer Research Laboratories 125

REFERENCE SECTION

How to Delineate Screw Threads—Part II: Representing the Thread and Denoting Functional Features ..... Robert V. Mac Kenzie 111

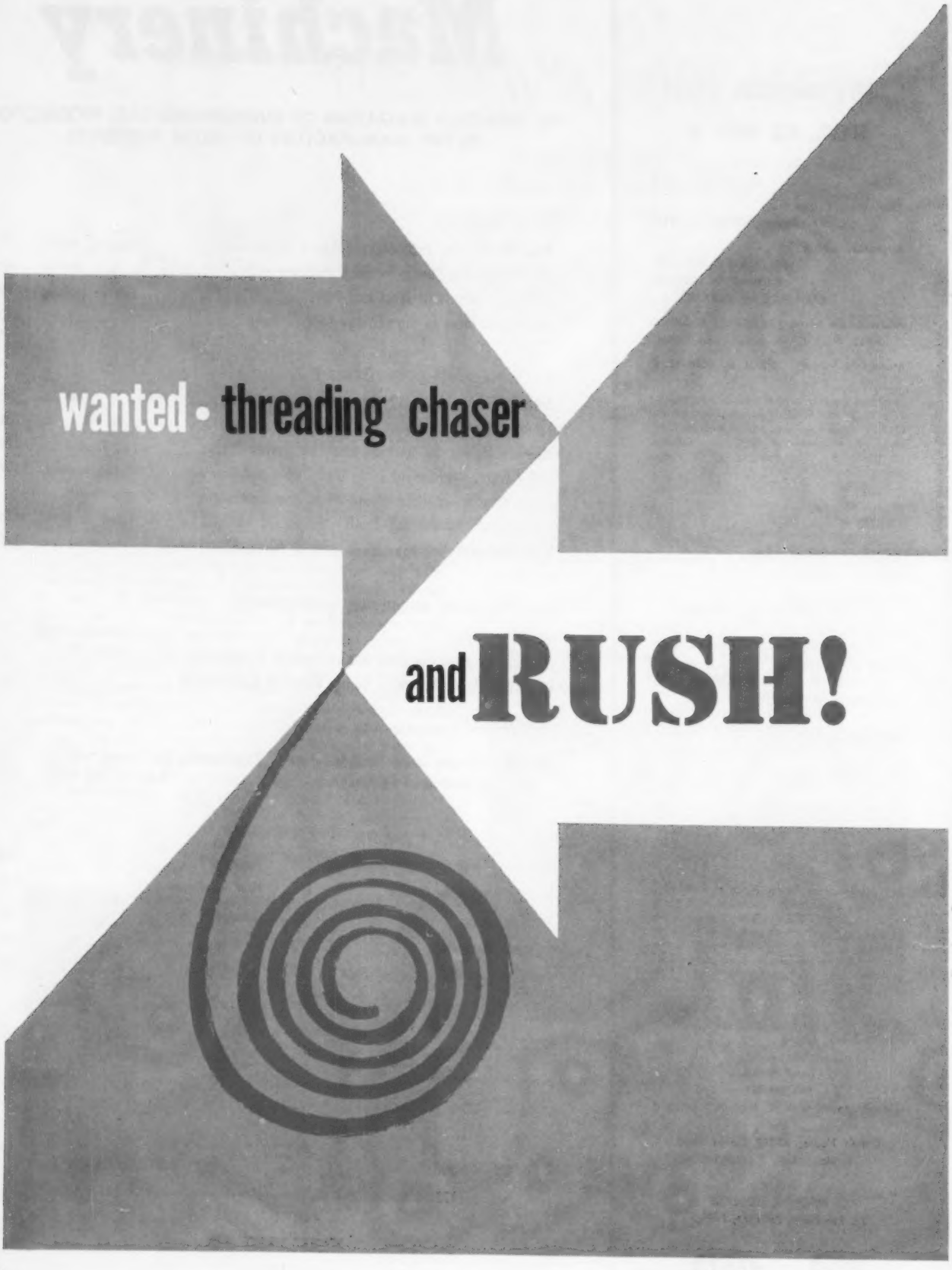
DEPARTMENTS

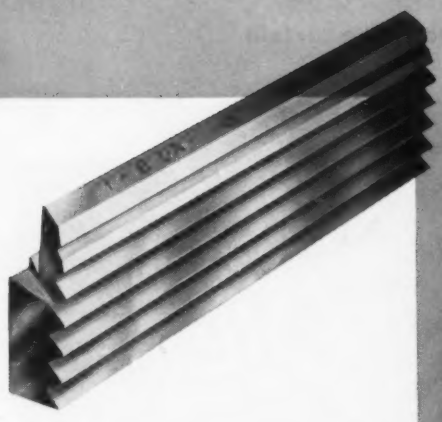
Keeping up with Washington 73
In Shops Around the Country 126
Tool Engineering Ideas 128
Ingenious Mechanisms 130
New Developments in Shop Equipment .. 136
Data Sheet 145
New Catalogues 164
Between Grinds 180
News of the Industry 220
Coming Events 228
Book Reviews 228

FREE INFORMATION GUIDE
175

ADVERTISERS' INDEX
239

READERS' SERVICE CARD
177


wanted • threading chaser
and RUSH!



There are threading chasers and there are threading chasers. But, there is one chaser which is better in several ways—right down to arriving in your plant on time from a rush order. It is the Landis Tangential Chaser, pioneered and introduced by the Landis Machine Co. It's better for these reasons:

1. *DELIVERY*—As good as the best; better than most. Landis maintains a large inventory of chasers in standard forms. As a result, rush orders on standard chasers are shipped within a few hours after the order is received. Standard chasers, for regular orders, are shipped the next day.

2. *INTERCHANGEABILITY*—Because Landis includes the helix angles in the chaser holder and not in the chaser, we are able to offer interchangeability. You do not need a set of chasers for each diameter you want to cut. As long as they are used within the wide range of the chaser holder, each set of chasers is interchangeable between different sizes and styles of die heads. This reduces your investment in chasers and keeps your inventory low. Interchangeability keeps your job running, too.

3. *UNIFORMITY AND QUALITY*—*All* Landis Chasers undergo a stern quality control routine. *All* of the same type are manufactured the same way and *all* are heat-treated in the same manner. Furthermore, Landis Chasers are often given special hardening treatment when workpiece design or material specifications so indicate. The ability to determine and apply the proper chaser hardening technique is the result of our over 55 years experience in a single field —THREADING. Quality also applies to the full complement of Landis Die Heads available with Landis Chasers.

4. *NO JOB TOO TOUGH*—We will tackle any threading job. Quite often Landis Chasers are chosen because competitive chasers cannot do the job. Landis Chasers have been proved successful on about every thread form there is—even Acme threads on large diameters!

5. *COST*—Landis Chasers are *very* competitive. In dollars and cents most competitive chasers will meet the Landis price, but when quality and tool life are taken into consideration the Landis Chaser will be chosen. Landis Chasers *are* better. Buy now and prove it to yourself.

LANDIS *Machine* COMPANY
WAYNESBORO • PENNSYLVANIA
THE WORLD'S LARGEST MANUFACTURER OF THREADING EQUIPMENT

819C

HIGH-SPEED HOBBING
TO MATCH YOUR PRODUCTION NEEDS . . .

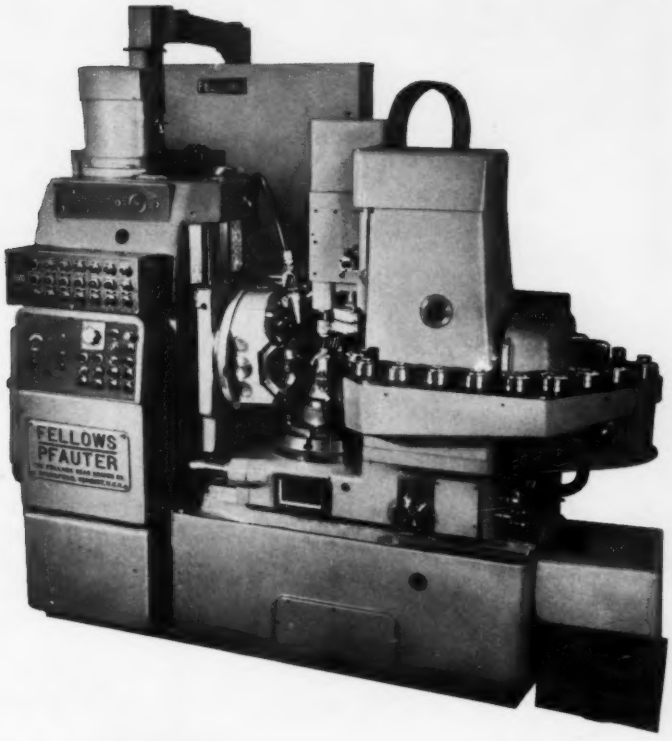
Choose the model FELLOWS-PFAUTER Hobbing Machine that best meets your work capacity requirements. With either machine you'll be certain of getting cost-cutting, high production performance.

Both models set up fast and are easy to handle. Work areas are easily accessible. Automatic retraction of table from hob facilitates work changes. Advanced design provides pushbutton hob shifting, built-in hydraulics for operation of tailstock and fixtures, and infinitely variable speeds and feeds. Construction is solid and rugged throughout.

Improve your productivity and profits with a FELLOWS-PFAUTER High-Speed Hobbing Machine. Write for complete details today.

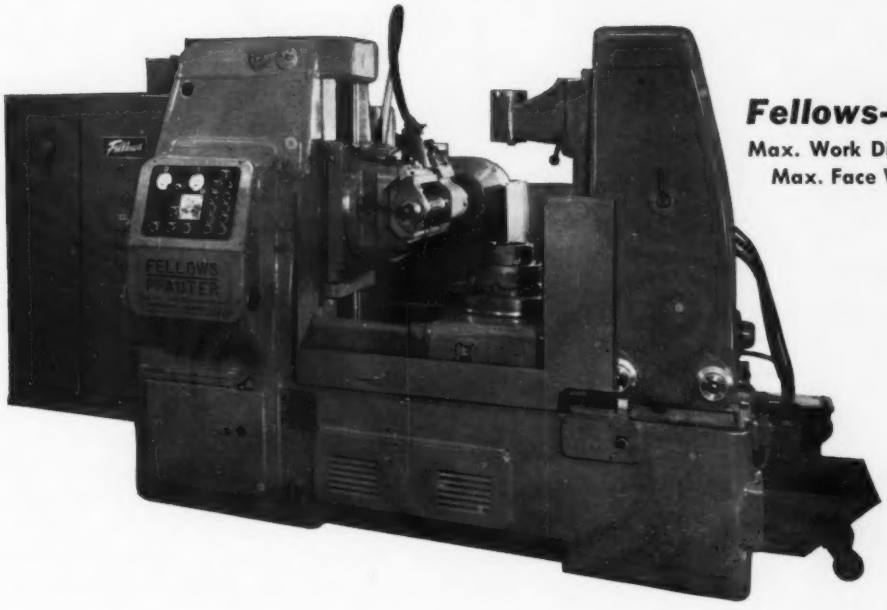
NEW . . . Dictionary of Change-Gear Combinations

"Fellows-Pfauter Change Gear Tables" by F. Becher and A. Koerner eliminates tedious calculations and trial-and-error methods. This English edition contains combinations for more than 26,000 ratios carried to six decimal places from .100,000 to 1.000,000, with the greatest step approximately .00005. Change gears in the range of 18 to 80 teeth are mainly used. Examples of applications are given. Only $8.00.
Get a copy now. Send your order to THE FELLOWS GEAR SHAPER COMPANY, 78 River Street, Springfield, Vermont, U. S. A.



Fellows-Pfauter P400

Max. Work Dia. — 16″; Max. D.P. — 4;
Max. Face Width — 11″ at 16″ dia.;
Hob R.P.M. — 80-500.



Fellows-Pfauter P630

Max. Work Dia. — 25″; Max. D.P. — 3;
Max. Face Width — 16¼″ at 25″ dia.;
Hob R.P.M. — 62-390.

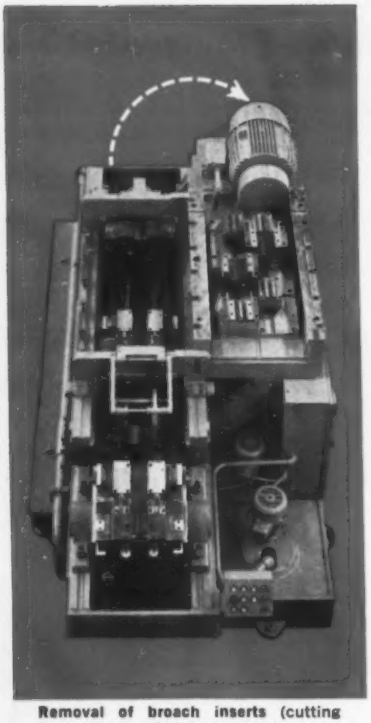
THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont, U.S.A.

Branch Offices:
1048 North Woodward Ave., Royal Oak, Mich.
150 West Pleasant Ave., Maywood, N. J.
5835 West North Avenue, Chicago 39
6214 West Manchester Ave., Los Angeles 45

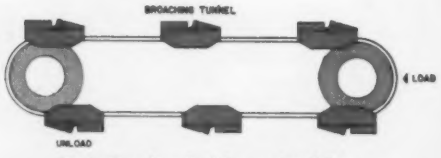
THE PRECISION LINE **Fellows** *Gear Production Equipment*

For more data, circle this page number on Readers' Service Card

New CINCINNATI *Chain Broach* IS ADAPTABLE TO CHANGE



Removal of broach inserts (cutting tools) for re-grinding is facilitated by merely opening the hinged top, as illustrated here.



Chain broach principle: a closed loop continuous production cycle. Fixtures indicated in red can be replaced or more added.

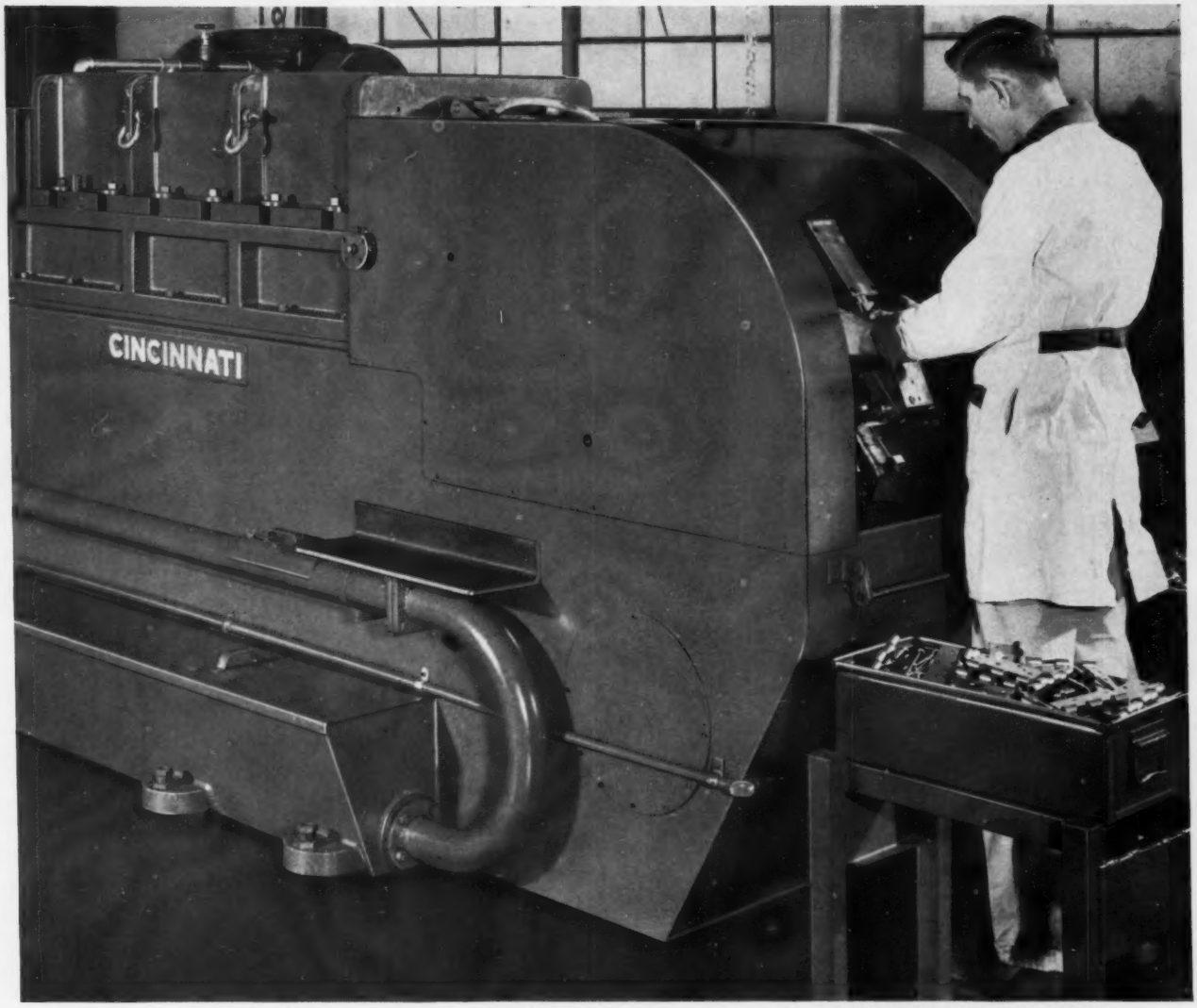
CHAIN BROACHING implies very high production. But very high production equipment sometimes limits design changes in the part. New CINCINNATI Chain Broach Machines retain the high production characteristics of closed loop cycles while adding a new advantage . . . they're adaptable to change. A unique method of attaching the work-holding fixture to the chains permits a welcome freedom of replacing or adding fixtures.

Straight-line traverse of fixtures through the broaching "tunnel" is assured by extra rugged guide bars. A pressurized coolant system and an endless conveyor automatically remove chips. To facilitate maintenance and adjustment of broach inserts (cutters), the top of the broaching tunnel is hinged and can be readily opened.

The CINCINNATI Chain Broach illustrated above is tooled up to

DESIGNERS AND BUILDERS OF SPECIAL MACHINES • HORIZONTAL BROACHING MACHINES •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

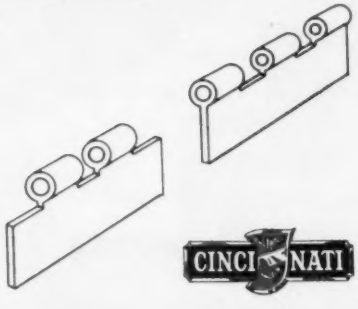


Photograph courtesy of Lawrence Brothers, Inc., Sterling, Illinois

New CINCINNATI Chain Broach Machine. Can be built in various sizes and tooled up for many types of high production jobs, such as machining the door hinge leaves shown below. Automatic chip disposal system is seen at front of machine.

broach door hinges for a prominent Illinois manufacturer of builders' hardware. Interchangeable fixture elements accommodate several sizes. With the exception of manual loading, the complete cycle is automatic and continuous, resulting in a production rate of 924 hinge leaves per hour.

The new Chain Broach Machine is a typical example of advanced thinking and modern approach to low-cost production which Cincinnati imparts to broaching and other metalworking machines and production lines. Many specialists in Cincinnati's Special Machine Division are available to study your machining problems and recommend equipment to reduce costs and improve quality. May we give you more information?



COMPLETELY AUTOMATED PRODUCTION LINES

CINCINNATI®
SPECIAL MACHINE DIVISION

Landis features give reliability to production grinding

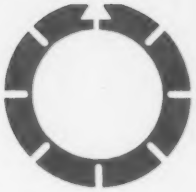
New Landis 10" Type R Plain Grinder

RELIABLE QUALITY PRODUCTION

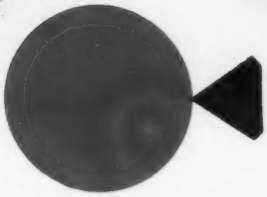
Consistent, automatic, repeat performance of a cylindrical grinder is dependent upon the combined reliability of all grinding machine essentials—work support, wheel support, wheelfeed and wheel dressing.

The exclusive features of the new Landis plain grinders are built around these four machine essentials to assure reliable, quality production.

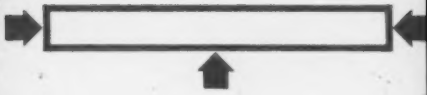
Wheelfeed. Exclusive Landis Microfeed® is an ultra-fine feed to final size. It is a pulse feed in millionths that automatically cancels all grinding variables such as wheel wear, machine temperature changes, wheel action and variations in workpieces.



Wheel support. Exclusive Microsphere wheel spindle bearing reduces sparkout time, speeds production.



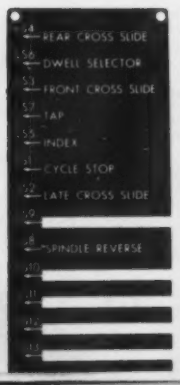
Wheel dressing. Exclusive Landis Truform dresser with ball slide, shake-free construction. Assures exact duplication of all wheel profiles.

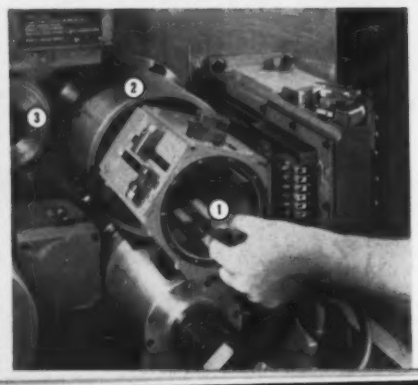


Work support. Exclusive wedge work rest and loaded ball spindle footstock give maximum rigidity to work parts.

LANDIS

LANDIS TOOL COMPANY, WAYNESBORO, PA.





Running medium to large lot sizes, one operator can easily handle more than one O-AC. Typical "AC" design permits use of standard shank-type turret lathe tools for complex work. Large number of tool stations often eliminates extra operations, handling of work pieces. O-AC has ample power and rigidity for heavy metal removal.

Fast setup lets you automate small-lot orders. Speeds, feeds and stroke lengths are set by placing trip blocks on Speed and Feed Control Drum (1). Pins screwed into Index Control Drum (2) regulate functions shown on plate at left. Supplementary Control Drum (3) regulates slight variations of standard machine functions—dwell, feed start—late cross slide, rapid traverse reverse, etc.

New chucker automates production of small precision parts

O-AC Single Spindle Automatic easily holds tenths. Accuracy, plus fast setup, rigidity and power give you a one-operation, precision automatic for all lot sizes.

This is more than a new "AC". This is the *smallest* "AC". It can profitably automate the jobs you now assign to precision hand-operated machines.

O-AC holds exacting tolerances on parts like these, proves practical on lot sizes once considered economical only for hand-operated machines.

Along with precision machining capabilities, you'll find we've built in all the setup, tooling and operating features that have proved their worth on our larger Automatics.

Thus you can use the O-AC to complete more jobs in one operation, combining multiple-tooled turret stations with cross-slide cuts. And, of course, you can schedule more jobs on the O-AC because it produces profitably on even very small lots.

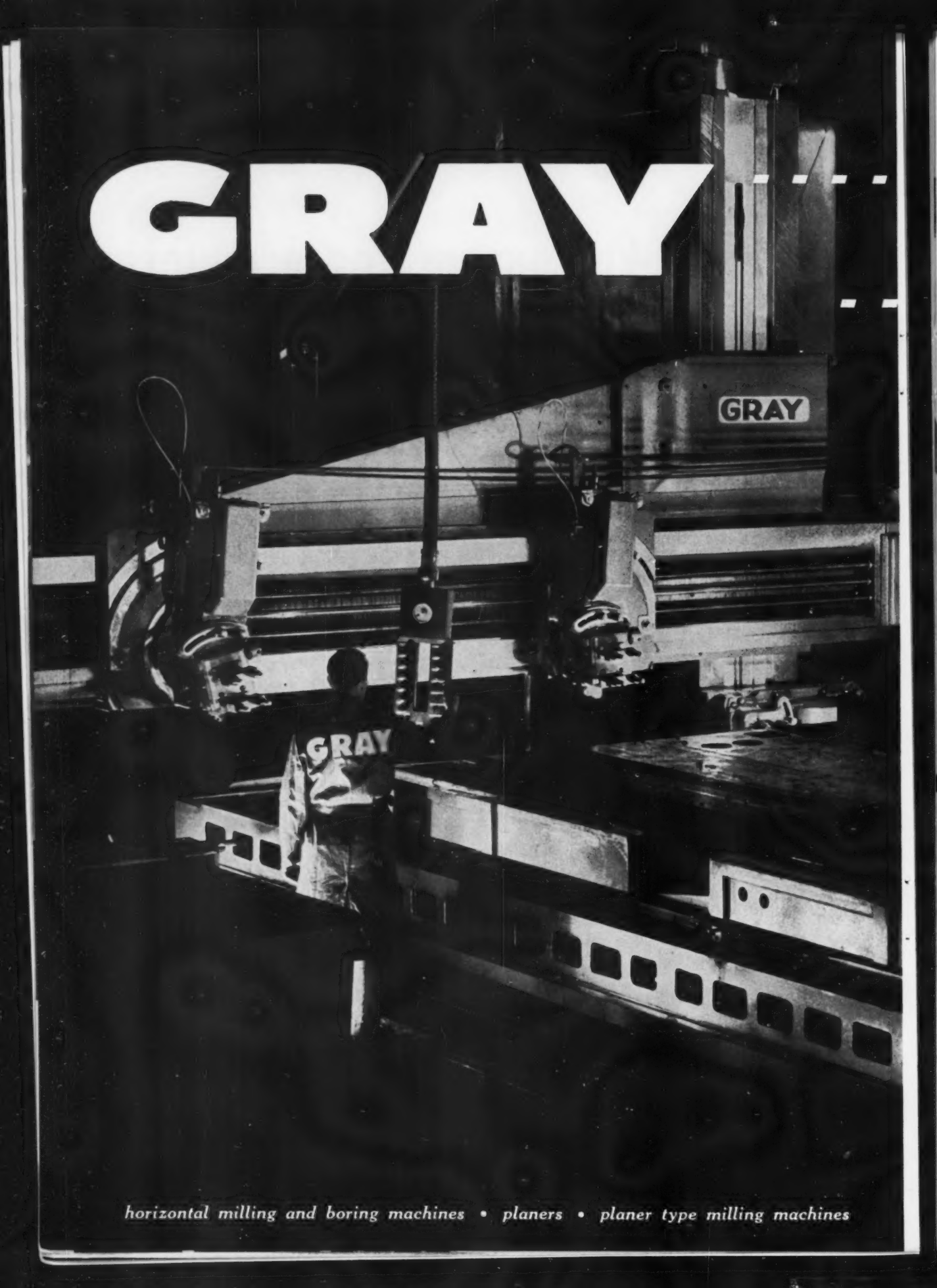
Does the O-AC belong in your shop? The Field Engineer is the man to ask. Or write The Warner & Swasey Company, Cleveland 3, Ohio.

MAJOR SPECIFICATIONS

SWING	
Over Cross Slides	6"
CHUCK DIAMETER	
Air operated	6"
WORKING STROKES	
Pentagon turret	3"
Cross slides	1½"
SPINDLE SPEEDS	
Four ranges	87-2507 rpm
FEEDS	
Three automatic selections from 18 feeds (.001 to .083)	
Threading range	11½-48 tpi
MOTOR	
Reversing type	5 or 7½ hp

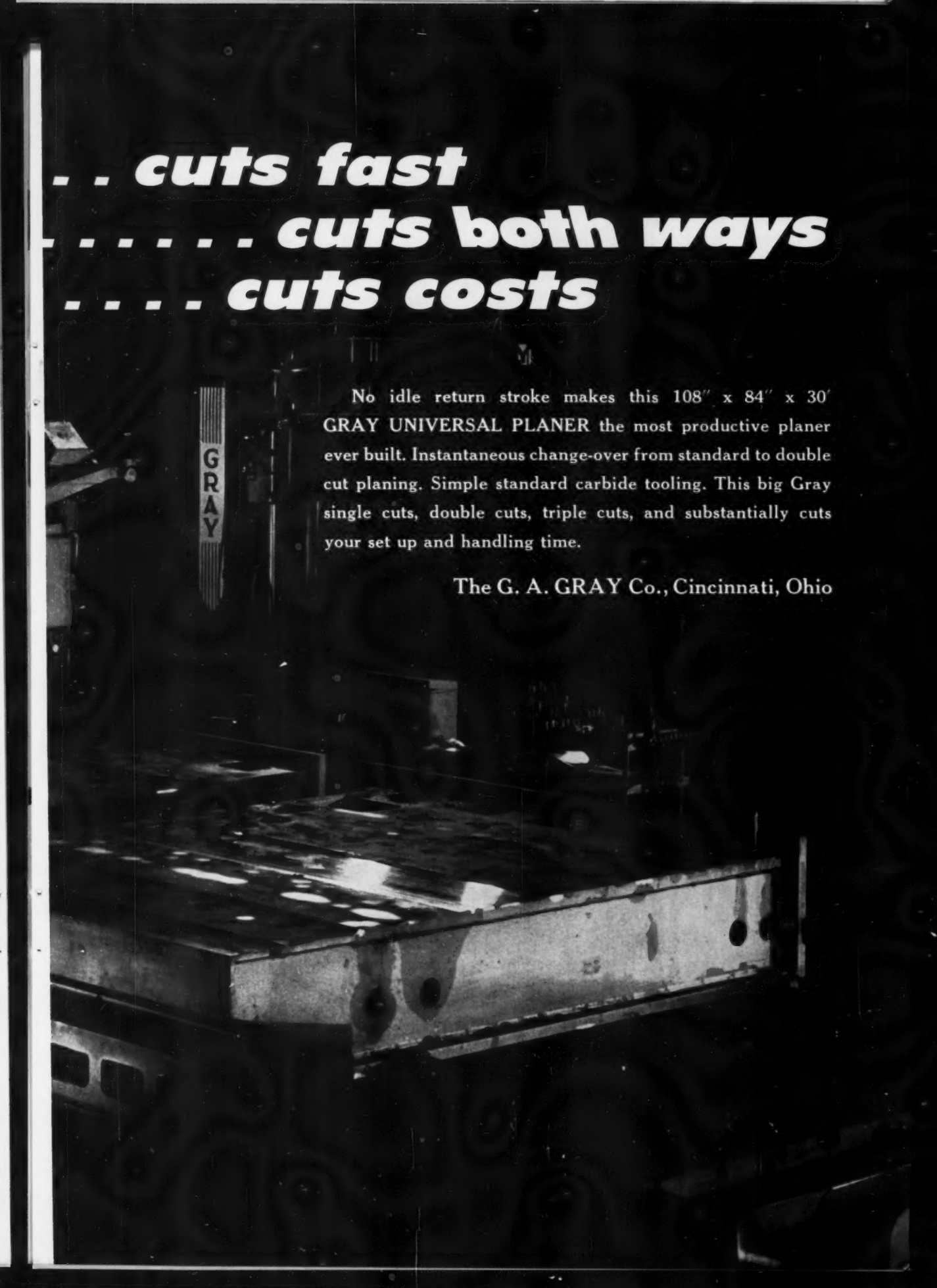
YOU CAN TURN IT BETTER, FASTER, FOR LESS...WITH A WARNER & SWASEY

WARNER & SWASEY



horizontal milling and boring machines • planers • planer type milling machines

. . cuts fast
. . . . . cuts both ways
. . . . cuts costs



No idle return stroke makes this 108″ x 84″ x 30′ GRAY UNIVERSAL PLANER the most productive planer ever built. Instantaneous change-over from standard to double cut planing. Simple standard carbide tooling. This big Gray single cuts, double cuts, triple cuts, and substantially cuts your set up and handling time.

The G. A. GRAY Co., Cincinnati, Ohio

ALMOST EVERY DAY
A NEW FLAG FLIES AT...

fair street

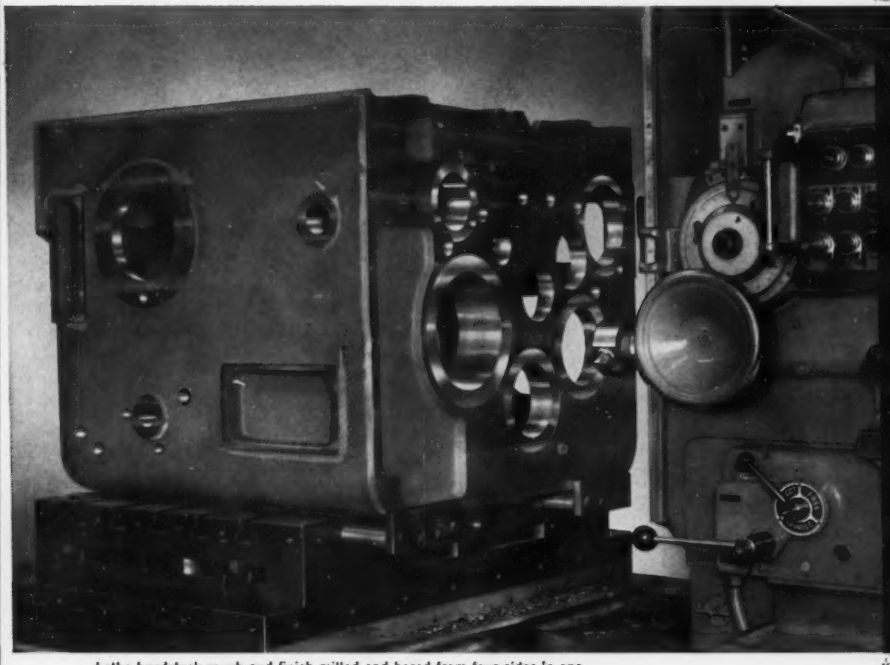
DE VLIEG MACHINE COMPANY, FAIR STREET • ROYAL OAK, MICHIGAN

Every few days, someone from another country visits Fair Street. He may come from Asia, Australia, Canada, Europe, Latin America; any part of the Free World. And when he arrives, we display his country's flag in our lobby.

WHY DO THEY COME . . . these important industrial leaders from all over the world? They come because they are interested in finding better ways of doing things. These men must find solutions to problems raised by the need for increased accuracy and higher productivity with readily available skills. Specifically, in the field of boring and milling, they've heard that the JIGMIL Technique and the DeVlieg concept of Precision Machining go a long way towards solving such problems. No one is ever disappointed. Every visitor, whether from overseas or local firms, is introduced to rewarding new concepts in machining. Concepts that once discovered, cannot be ignored.

SOME OF OUR OVERSEAS USERS

A. B. Bofors—Bofors
Alfa Romeo—Milano
Alfred Herbert Ltd.—Coventry
Ateliers de Constructions Electriques de Charleroi—Charleroi
Ateliers G.S.P.—Chateaudun
Automobiles Peugeot—Buenos Aires
Brdr. Gram—Vojens
Bristol Aeroplane Co. Ltd.—Filton, Bristol
Brunner Corporation (Canada) Ltd.—Port Hope, Ontario
Canadair Ltd.—Laurent, Montreal, P.Q.
Daimler-Benz Aktiengesellschaft—Stuttgart
Ets. R. Messian—Cambrai, Nord
Fabrique Nationale d'Armec de Guerre—Liege
Fiat, Sezione Automobili—Torino
[illegible] Maschinenfabrik GmbH—Nuertingen
G. M. Rodger's Limited—Melbourne
Hispano Suiza Ltd.—Geneva
Kawasaki Ltd.—Kawasaki
Holland Signaal App. Fabriek—Hengelo
Innocenti—Milano
International Harvester Co. of Australia Pty. Ltd.—Geelong, Victoria
Kirloskar Oil Engines Ltd.—Poona
KLM Royal Dutch Airlines—Holland



Lathe headstock rough and finish milled and bored from four sides in one setup on a 3B-48 JIGMIL. Total machining time is approximately 8 hours.

WHAT YOU'LL SEE WHEN YOU COME TO FAIR STREET

- DeVlieg JIGMILS with Standard Controls, Diatrol and Tapac
- The Micropoint Tool Grinder
- The Microbore System of Precision Tooling

K. Martin Maschinenfabrik—Offenburg-Baden
Kobe Steel Works—Kobe
Lidkopings Mek. Verkstads A.B.—Lidkoping
Maquinas Agricolas Romi S.A.—Sao Paulo
Mitsubishi Heavy Industries—Nagoya
Praga Tools Corp. Ltd.—Secunderabad
Regie Nationale des Usines Renault—Billancourt
R. Hoe & Co. Ltd.—London
Rolls Royce Ltd.—Derby
Sud-Aviation—Bouguenais
Sulzer Brothers Ltd.—Winterthur
Svenska Flygmotor A-B—Trollhattan
Toyota Motor Co.—Toyota
Vald. Henriksen—Copenhagen
Vickers-Armstrongs Ltd.—Crayford, Kent
Vickers Ruwolt Pty. Ltd.—Melbourne
Volkswagenwerk GmbH—Wolfsburg
Von Roll Iron Works Ltd.—Klus
York Gears, Ltd.—Toronto, Ontario

WILL YOU BE THE NEXT TO VISIT FAIR STREET

DeVlieg

SPIRAMATIC JIGMILS®

ACCURATE HOLES AND FLAT SURFACES IN PRECISE LOCATIONS

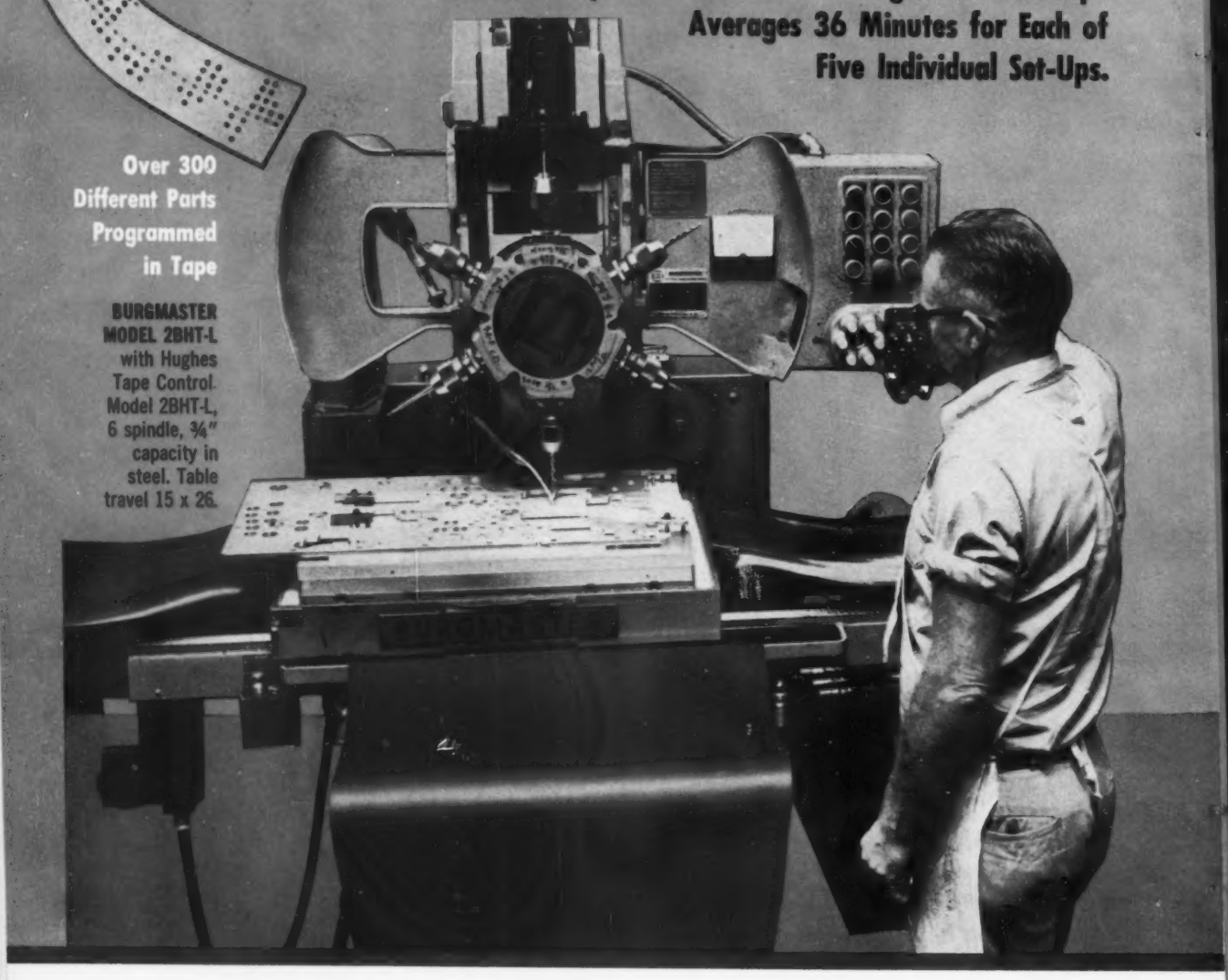
For more data, circle this page number on Readers' Service Card.

LIBRASCOPE DIVISION, GENERAL PRECISION, INC.

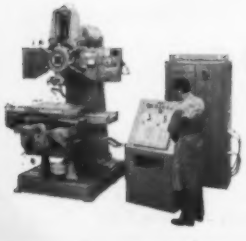
USES Burgmaster

1,016 Operations Each Part Programmed in Tape Averages 36 Minutes for Each of Five Individual Set-Ups.

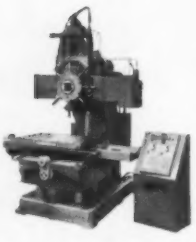
Over 300 Different Parts Programmed in Tape



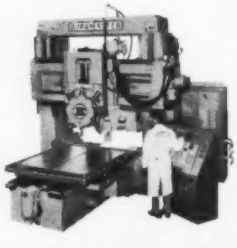
BURGMASTER MODEL 2BHT-L with Hughes Tape Control. Model 2BHT-L, 6 spindle, ¾" capacity in steel. Table travel 15 x 26.



MODEL 25AHT 6 spindle, 1¼" capacity in steel. Table travel 15 x 26, 20 x 30, 30 x 45.



MODEL 3BHT 8 spindle, 1½" capacity in steel. Table travel 20 x 30, 30 x 45.

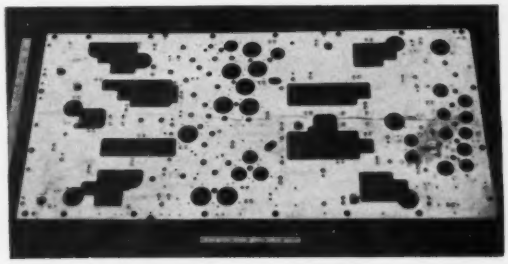


MODEL 3BHT-B Double Housing Planer Type 8 spindle, 1½" capacity in steel. Table travel 48 x 60.

TAPE-CONTROLLED TURRET DRILLS

SAVES $1850.00 TOOLING COSTS...CUTS PRODUCTION TIME FROM 7.3 TO 2.2 HRS.

Librascope Division, General Precision, Inc., Glendale, California uses several Burgmaster Turret Drills to increase production and reduce costs. For example, over 300 different jobs are programmed in tape for use on their tape-controlled Burgmaster Model 2BHT-L. In this group there is a single part with 1,016 center drilling, drilling, tapping and reaming operations with tolerances as close as ±.0005 programmed in tape. As a result, production has been increased 330% with a labor savings of over 90%. Fixture savings on this one job amounted to $1850.00, with set-up time reduced to just 36 minutes for each of five set-ups. When you project this type of savings over 300 different jobs you can see why you should get the facts on Burgmaster Tape-Controlled Turret Drilling Machines.



6061T6 aluminum alloy digital computer base plate 14⅜" x 29¾₆" x ½" showing result of total 1,016 center drilling, drilling, tapping and reaming operations performed by Burgmaster Tape-Controlled Turret Drilling Machine.

—JOB FACTS—

Company: Librascope Division, General Precision, Inc., Glendale, California.
Machine: Burgmaster Model 2BHT-L (with Hughes' Tape Control) Turret Drilling, Tapping, Milling and Boring Machine.
Part: Digital computer base plate, 14⅜" x 29¾₆" x ½", 6061T6 aluminum alloy.
Lot Size: 10
Tolerance: ±.0005
Holding: Locating pins on sub base and simple clamps.
Machine Operations: Total 1,016 machine operations.
413 holes center drilled
424 holes drilled
158 holes tapped
21 holes reamed
Former Method: Single-spindle drilling machines with fixtures.
Present Method: Tape-Controlled Burgmaster Model 2BHT-L Turret Drilling, Tapping and Boring Machine.
Savings: 5.1 hours per part, 90% of labor costs, and $1850.00 fixture cost.
Other Advantages: Greater accuracy, less cost, no scrap loss, eliminates operator fatigue, fast set-ups, economically handles mill lot work.

Burgmaster Corporation

15001 S. Figueroa Street, Gardena, California • FAculty 1-3510, DAvis 9-4158
BURGMASTER DIRECT SALES OFFICES: Midland Park, New Jersey, 196 Greenwood Road, GIlbert 4-3002 • **Melrose Park, Illinois,** 2307 N. Mannheim Road, GLadstone 1-2828 • **Cleveland, Ohio,** ACademy 6-7030 • **Detroit 37, Michigan,** 13730 W. Eight Mile Road, LIncoln 8-4333 • **Northern California, Castro Valley,** 4611 Emily Court, JEfferson 7-1650 • **Kearney & Trecker, C.V.A. Ltd.,** Sole Agents for Great Britain, British Commonwealth and Western Europe • **Mitsubishi Corp.** for Japan, Far East, and South America.

Send for Literature

Write for bulletin describing Burgmaster 6- and 8-Spindle Tape-Controlled Turret Drilling, Tapping and Boring Machines. Forty-minute, 16 mm sound film showing all Burgmaster Turret Drills in operation is available without charge from any office.

World's Largest Builder of Turret Drilling Machines

"0" Manual Power Index ¼" Capacity

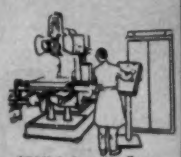
1C Manual Power Index ⅜" Capacity

2B Manual Power Index ¾" Capacity

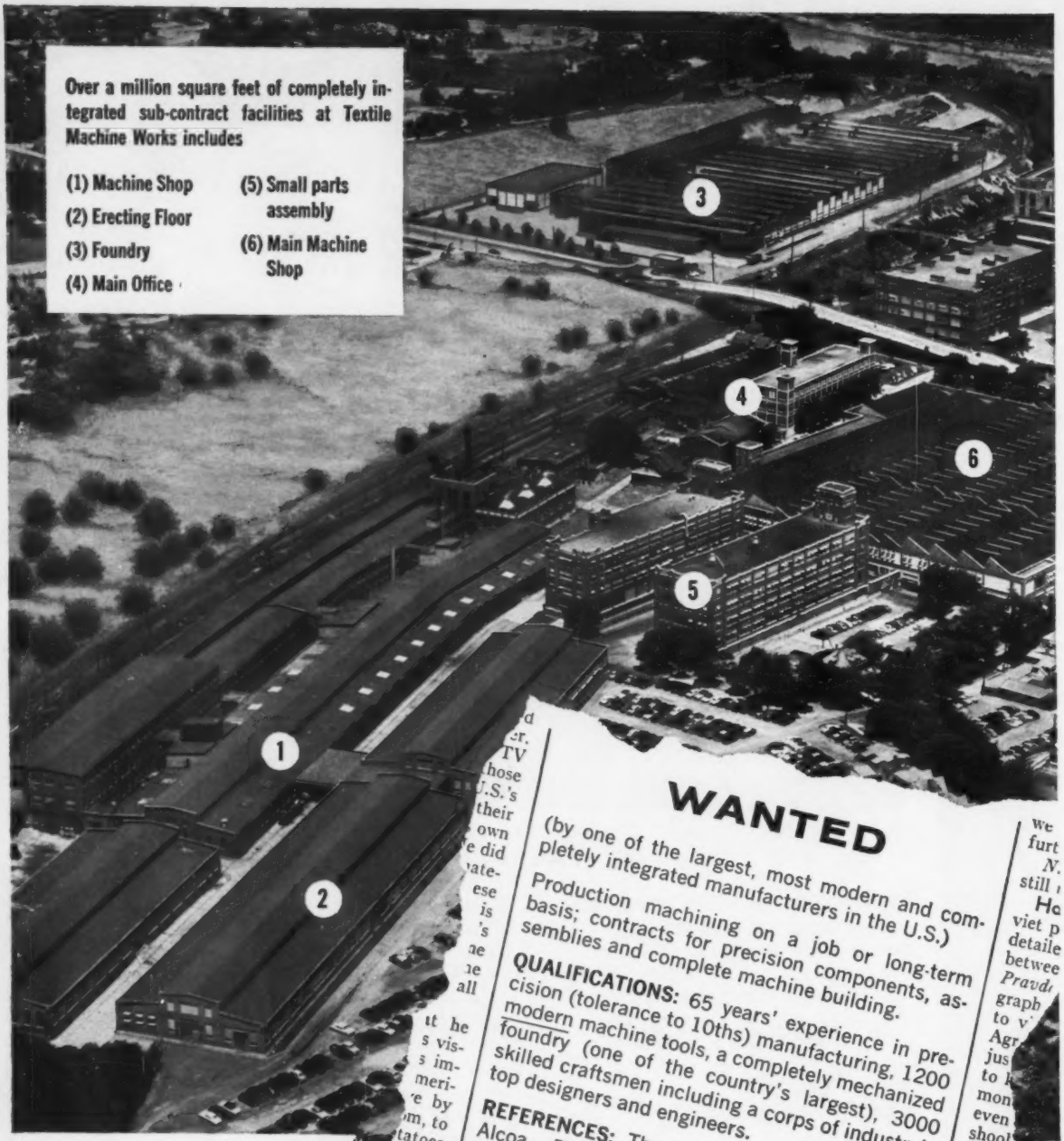
2BR Ram Type Radial Drill ¾" Capacity

2BH Automatic Hydraulic ⅜" Capacity

3BH Automatic Hydraulic 1½" Capacity


25AH Automatic Tape Controlled 1¼" Capacity

2BHT-3BHT Automatic Tape Controlled ¾" and 1½" Capacity



WANTED

(by one of the largest, most modern and completely integrated manufacturers in the U.S.)

Production machining on a job or long-term basis; contracts for precision components, assemblies and complete machine building.

QUALIFICATIONS: 65 years' experience in precision (tolerance to 10ths) manufacturing, 1200 modern machine tools, a completely mechanized foundry (one of the country's largest), 3000 skilled craftsmen including a corps of industry's top designers and engineers.

REFERENCES: The best . . . companies like Alcoa, Du Pont, Chrysler, Eastman Kodak, Western Electric, Fairchild Aircraft, Ingersoll-Rand and others who know they can depend on TMW for quality, accuracy and on-time delivery at minimum costs.

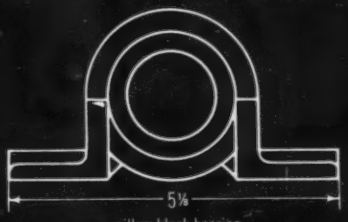
For more details, or for new Facilities File Folder call or write today.

TEXTILE MACHINE WORKS
CONTRACT DIVISION, READING, PENNA.

NEWEST SINGLE SURFACE DISC GRINDER

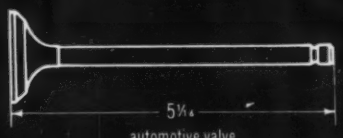
Greater rigidity of new Gardner 1H20 results in improved precision and reliability at high production rates

disc grinds parts like these

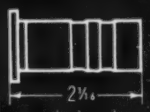


pillow block bearing

connecting rod cap



automotive valve



valve tappet

typewriter part

This new disc grinder has a 23" disc and can be equipped with 10, 15 or 20 hp spindle drive motors. Manual or automatic loading.

GARDNER

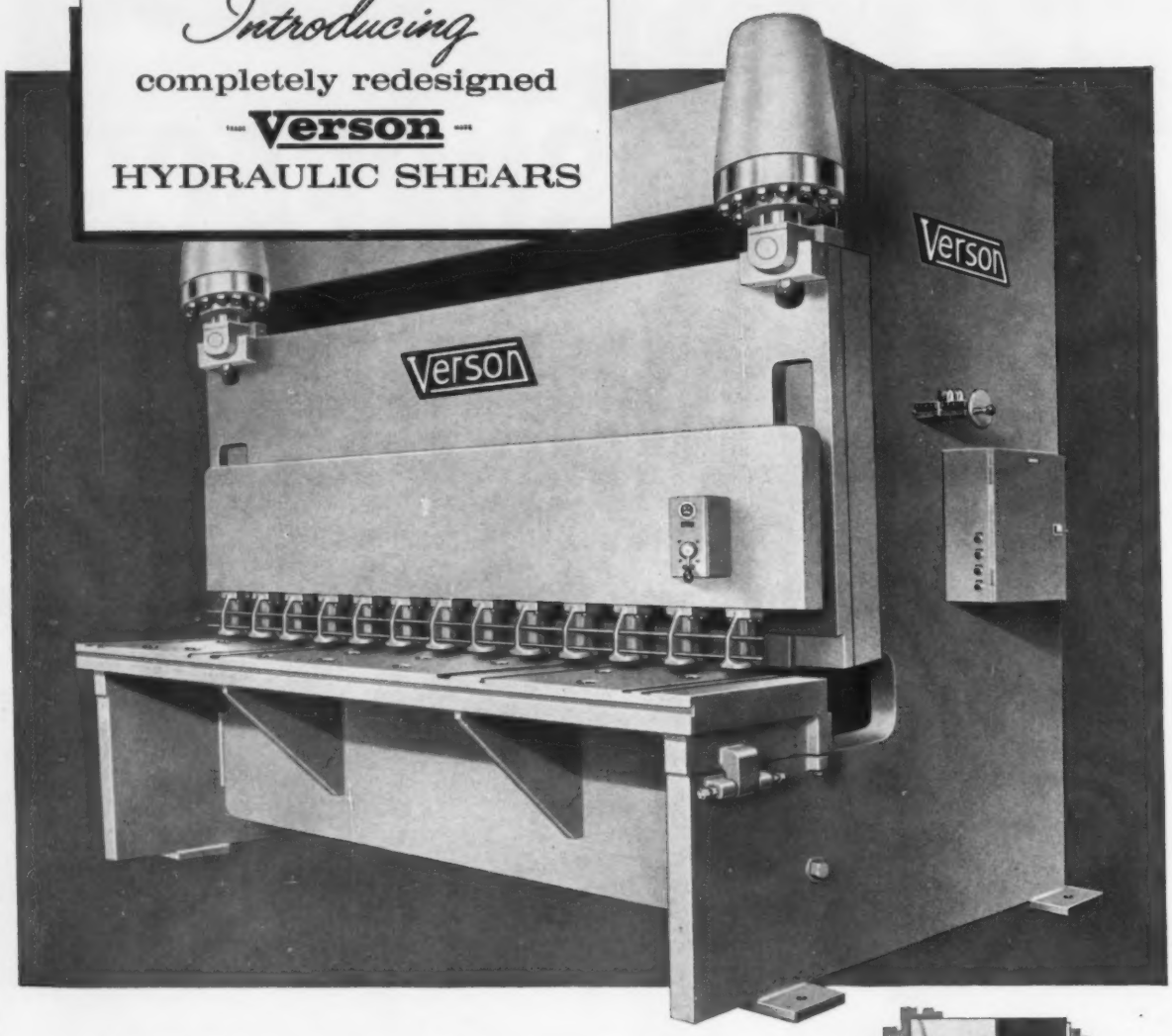
GARDNER MACHINE COMPANY, BELOIT, WISCONSIN

Introducing

completely redesigned

Verson

HYDRAULIC SHEARS



Better performance ... lower costs ... greater reliability ... these are the benefits you can get from the new Verson Hydraulic Shears.

Redesigned from the floor up, Verson Hydraulic Shears incorporate the features you have said you need the most for profitable shearing operations. Steel cylinders insure low stresses, are keyed to frame to maintain precise alignment. Self centering ram end connections automatically maintain shear load to proximity of shear blade edge. Extra length gibbing provides greater ram control, assuring increased shearing accuracy. Deep and compact ram and holddown support minimize vibration. Simple, easily adjusted and maintained controls and adjustments simplify use.

Ask to have a Verson representative go over your shearing requirements, soon. Call or write.

Ask for the Verson Shear Selection Packet. Bulletin VHS-61 presents design details and specifications for the Verson Shear line. The new Verson shearing tonnage calculator is a handy slide calculator for making a variety of shearing calculations quickly and easily.

Verson

Originators and pioneers of allsteel stamping press construction

VERSON ALLSTEEL PRESS CO.

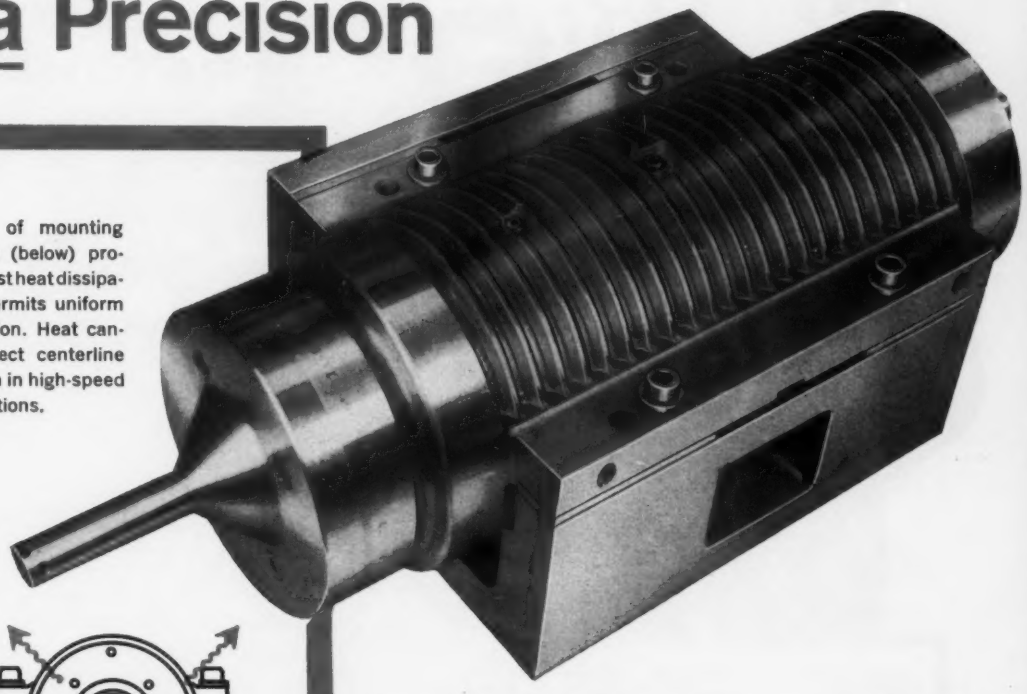
9309 S. Kenwood Avenue, Chicago 19, Illinois • 9309 S. Central Expressway, Dallas, Texas

MANUFACTURERS OF MECHANICAL AND HYDRAULIC PRESSES AND PRESS BRAKES • TRANSMAT PRESSES • IMPACT MACHINING PRESSES
TOOLING • DIE CUSHIONS • VERSON-WHEELON HYDRAULIC PRESSES • HYDRAULIC SHEARS • PLASTICS MOLDING PRESSES

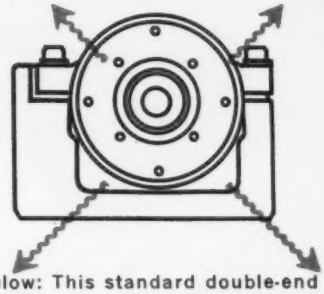
356-C

For more data, circle this page number on Readers' Service Card

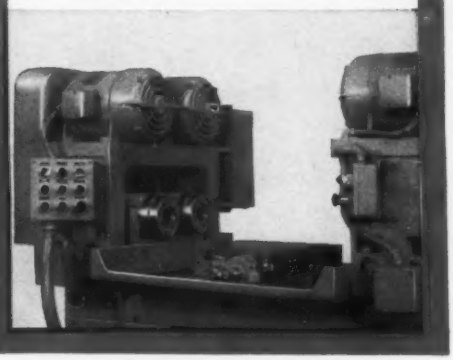
NEW Ex-Cell-O Spindles for Ultra Precision



Design of mounting bracket (below) provides fast heat dissipation, permits uniform expansion. Heat cannot affect centerline position in high-speed applications.



Below: This standard double-end Ex-Cell-O Precision Boring Machine provides a steady platform for the ultra-precision boring job described at right.



The special spindle shown above is one of 16 identical Ex-Cell-O Ultra Precision Boring Spindles recently developed for an extremely demanding boring operation.

Customer specifications called for a guaranteed maximum allowable .00003″ on roundness, with a 10 RMS or better surface finish. The spindles Ex-Cell-O delivered have consistently held .00002″ on roundness, with a 6 micro-inch surface finish (and the customer has ordered duplicates)!

Why do the new Ultra Precision Spindles and other standard and special Ex-Cell-O Boring and Grinding Spindles give consistently greater accuracy, finer finishes and longer, trouble-free life?

The answers are: Engineering and production experience (more than 40 years); exclusive design and construction (using famous Ex-Cell-O Spindle Bearings); and job-tailored availability (Ex-Cell-O offers the most comprehensive line of belt-driven, air-driven, motorized and high-frequency spindles available today).

Need fast delivery of Precision Spindles for original equipment or replacement use? Call your Ex-Cell-O Representative today, or contact Ex-Cell-O in Detroit.

60-85

EX-CELL-O FOR PRECISION

Machinery Division

PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • JIG AND FIXTURE COMPONENTS • TORQUE ACTUATORS • CONTOUR PROJECTORS GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

For more data, circle this page number on Readers' Service Card

New ARMSTRONG "90" SERIES RATCHET

The ONLY Ratchet with ALL these important features!

1. Slenderized head
2. Thumb-operated reversing lever specially designed so it won't come off
3. Reversing-lever stop (Ball-and-spring prevents accidental shifting)
4. Simple to clean—only tool required is a Phillips screwdriver (wearable parts may be individually replaced)
5. Thin handle with knurled grip
6. Hole in handle for convenient hanging
7. Fine-toothed gear
8. Easy ratcheting action
9. ¼", ⅜", and ½" square drives (two handle lengths in ½" drive)

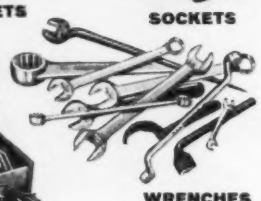
All wearable parts of ARMSTRONG Ratchets can be replaced individually, inexpensively, and easily. Entire ratchet handles need not be replaced in the event of tooth wear, as is necessary with ratchets in which the teeth are formed in the head of the handle.

* The name ARMSTRONG on these fine tools is your assurance of highest quality. Manufactured under strict quality control, all ARMSTRONG Tools can be used with confidence.

Extra heavy duty "50" Series ARMSTRONG ratchets (illustrated at right) are manufactured in 1", ¾", ½", and ⅜" square drive sizes. For complete information on these, as well as the approximately 5500 other tools in the ARMSTRONG Line, see General Catalog #700. Your local ARMSTRONG Distributor can supply you with Catalog #700 and can show you the new "90" Series Ratchets. If you do not know who handles the ARMSTRONG Line in your area, we will be glad to furnish this information upon your request.

EXTRA HEAVY DUTY RATCHETS

SOCKETS



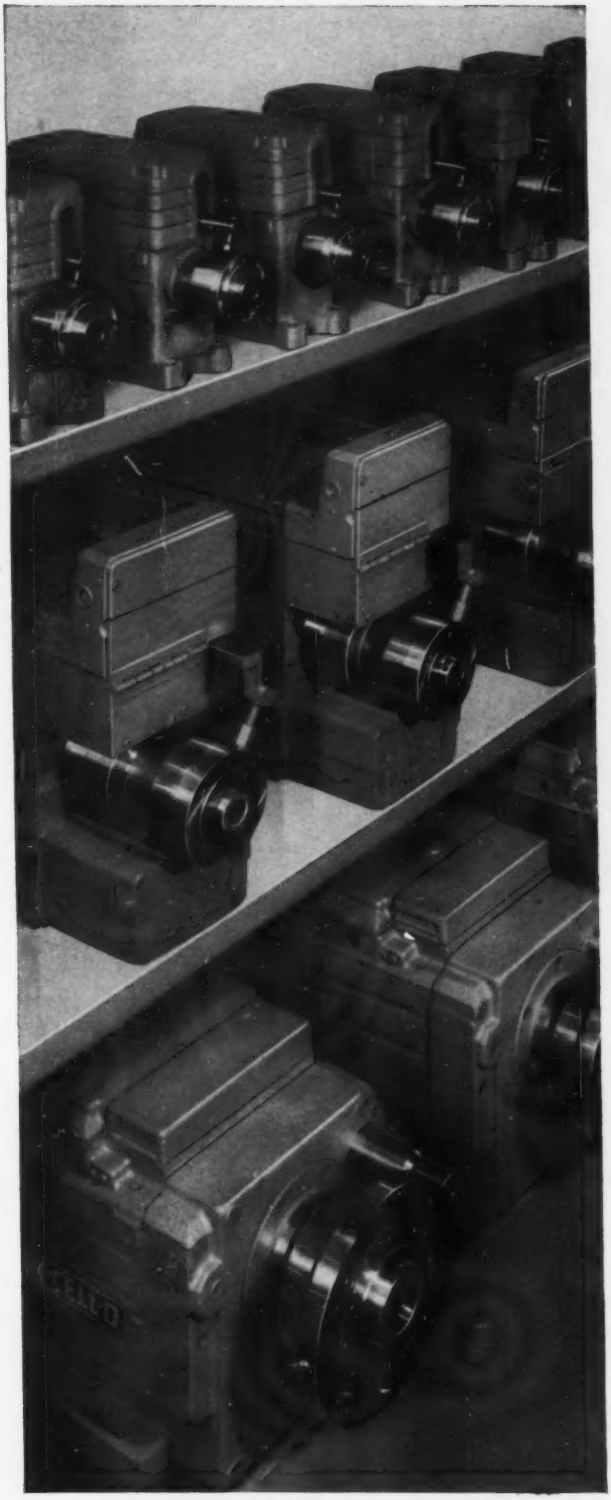
WRENCHES

WRENCH SETS

Buy ARMSTRONG TOOLS from your Industrial Distributor

ARMSTRONG BROS. TOOL CO.

5213 W. ARMSTRONG AVE. • CHICAGO 46, ILLINOIS



NEED Power Units in a Hurry?

Ex-Cell-O gives you off-the-shelf delivery!

In stock for immediate delivery, Ex-Cell-O Hydraulic Power Units are available in four quill-type models offering a wide range of spindle speeds, horsepower, stroke and thrust.

Self-lubricating for low maintenance, and precision-built for long life, Ex-Cell-O Hydraulic Power Units, and our Canadian-built lead-screw type Tapping Unit, are designed for drilling, reaming, tapping, spotfacing and other single or multiple operations, and for heavy-duty boring and milling machine applications. Pre-set start, rapid approach and return, dwell, reverse and stop are fully automatic.

Your Ex-Cell-O Representative has complete specifications, or write direct for our catalog. The model you need is on the shelf now—ready for same-day shipment to your plant!

61-21MA

EX-CELL-O FOR PRECISION

PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • JIG AND FIXTURE COMPONENTS • TORQUE ACTUATORS • CONTOUR PROJECTORS GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

Machinery Division

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

For more data, circle this page number on Readers' Service Card

How Convair-Astronautics keeps track of this...

(and 84,999 other missile parts)

The Manufacturing Control Department at Convair (Astronautics) Division of General Dynamics Corporation has a monumental problem: how to keep track of the movement of over 85,000 individual missile parts.

The solution: *automated data preparation* by means of a Friden Collectadata® system. Situated in key plant locations, Collectadata transmitters report virtually all parts movements—over 5000 every day—to central Collectadata receivers which record them into punched paper tape. At day's end the Collectadata tapes are fed into the electronic computer at Astronautics for further data processing.

This is what Astronautics says: *"The Collectadata has been in use at Astronautics for less than a year. But by eliminating tedious manual paperwork, and by assuring prompt processing of all inventory reports, it has already saved considerable time, trouble and money."*

How much could Collectadata save you? Call your Friden Systems Man, or write: Friden, Inc., San Leandro, Calif.

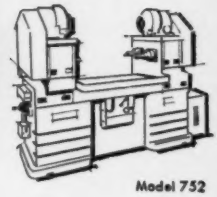
THIS IS PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it.

Sales, Service and Instruction Throughout the U. S. and World

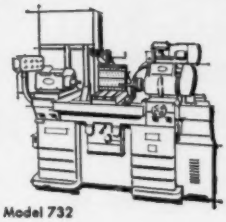
Friden

7 REASONS WHY THESE 4 NEW EX-CELL-OS CUT COSTS

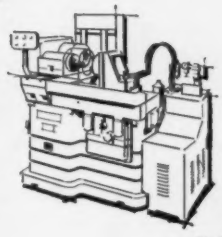
Model 751



Model 752



Model 732



Model 731

Designed and built for maximum dimensional stability under all operating conditions, these new hydraulically operated precision boring machines offer the ultimate in accurate repeatability.

Check these features for production efficiency . . .

- **Temperature controlled hydraulic panels**
- Extreme rigidity and stability in bases and tables
- Hydraulic and coolant system externally mounted
- Ex-Cell-O standard and tapered roller bearing spindles
- Designed for close-tolerance precision boring, turning, facing, counterboring, chamfering, grooving, recessing and trepanning operations.
- May be operated either manually or automatically.
- Engineered for simple installation into automated production lines.

Contact your Ex-Cell-O Representative or write direct for details.

61-87M

EX-CELL-O FOR PRECISION

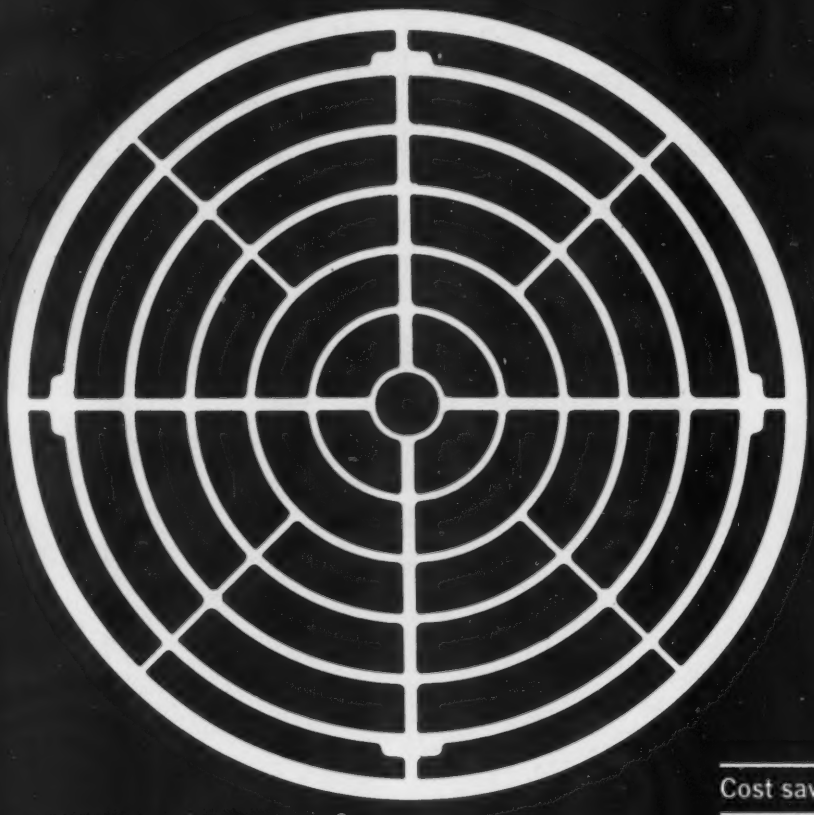
PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • JIG AND FIXTURE COMPONENTS • TORQUE ACTUATORS • CONTOUR PROJECTORS GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

Machinery Division

EX-CELL-O CORPORATION

DETROIT 32, MICHIGAN

For more data, circle this page number on Readers' Service Card



Cost saving: 33%

"are you getting your metal's worth?"

The intake tubes of the Waterous Company's model CMB fire pump suck in **1250** gallons of water a minute. Rocks and other foreign matter can get sucked in too—which would have disastrous effects on the pump. A screen is needed on the intake tubes, a screen that's tough and corrosion resistant, with extra-thin vanes and a smooth surface for unimpeded water flow.

Originally these screens were fabricated from sheet brass, with the vanes brazed together. An expensive material and method for a simple but important component. **Today these screens are die cast of Zamak at a cost saving of 33%** by Twin City Die Casting of Minneapolis. The tapered vanes have a minimum wall thickness of 1/32 of an inch. Zamak is the only die casting material that can fill these thin sections and still provide the strength, corrosion resistance and smooth "as cast" surface necessary.

To find out how you can put zinc die casting to work cutting your production costs, write today to The New Jersey Zinc Company for your set of Zamak technical data books detailing the properties, use, design techniques and machining practices of the Zamak alloys. Remember—Zamak gives you more for less. Are you getting your metal's worth?

HORSE HEAD® SPECIAL ZINC AND HORSE HEAD ZAMAK ARE PRODUCED BY

THE NEW JERSEY ZINC COMPANY

160 FRONT STREET • NEW YORK 38, N. Y.

DEVELOPERS OF THE ONLY STANDARD ZINC DIE CASTING ALLOYS IN USE TODAY

HORSE HEAD PRODUCTS

Ex-Cell-O Drill Jig Bushings

Uniform Hardness, Uniform Quality in More Than 11,000 Cataloged Bushings for metal or plastic jigs!

In stock now from coast to coast, Ex-Cell-O Drill Jig Bushings are made from the finest chrome-alloy bearing steel, precision-ground inside, outside and under the head. Steel bushings are held to consistent 62-64 Rockwell C Hole hardness.

Ex-Cell-O carbide bushings are made from the finest material available.

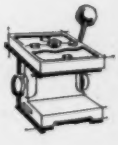
Select from one of the largest inventories in the U. S.

FREE DATA—See your local Ex-Cell-O Representative or Distributor for catalogs and bulletins on Drill Jig Bushings and other jig and fixture cost-cutters. Or contact Ex-Cell-O direct: Phone TOwnsend 8-3900; TWX—DE 876; Wire ZTC.

COMPONENTS FOR ALL YOUR JIG AND FIXTURE NEEDS—AVAILABLE IMMEDIATELY FROM A SINGLE, RELIABLE SOURCE!

Fixture Components—Clamp assemblies and fixture details.

Lift-Swing Fixtures—For fast drilling of difficult holes.



Micron Sections—Cast-iron shapes precut to your needs.

Reader Service Card Number is for Drill Jig Bushing Literature only. Request literature on above items separately.

61-18 BU

EX-CELL-O FOR PRECISION

PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • JIG AND FIXTURE COMPONENTS • TORQUE ACTUATORS • CONTOUR PROJECTORS GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

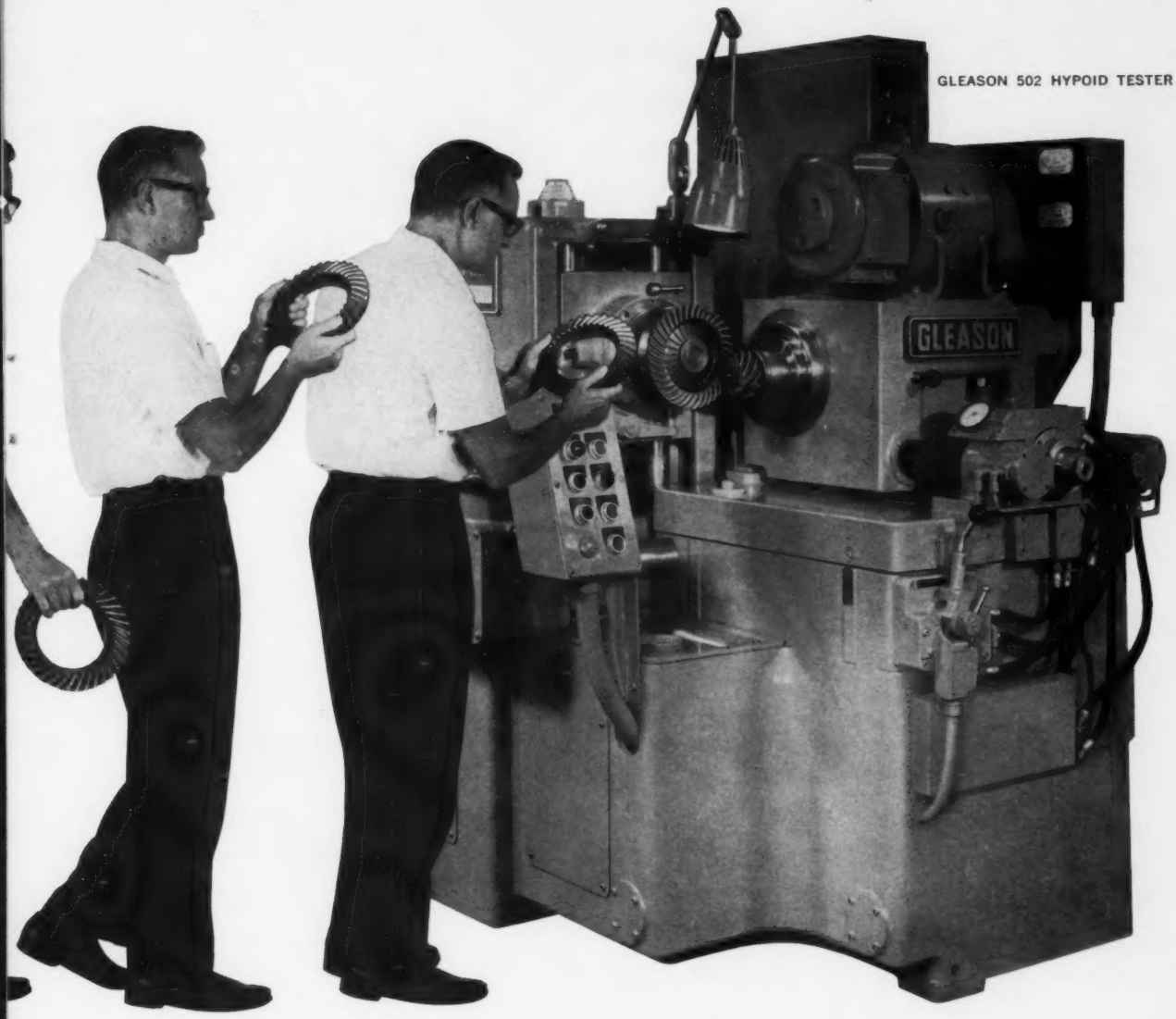
Bushing Sales Division

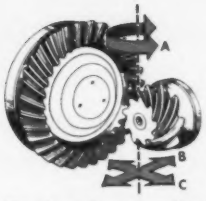
EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

GLEASON 503 HYPOID LAPPER

NEW SPC* MOTIONS FOR PRECISION LAPPING AND TESTING

GLEASON 502 HYPOID TESTER





*Swing Pinion Cone lapping motions—the swing motion of the pinion head "A" moves the bearing along the length of the tooth. The axial motion of the pinion head "B" moves the bearing up and down the tooth profile, while the motion of the pinion head in the direction of the gear axis "C" maintains constant backlash.

Designed primarily for testing and lapping automotive spiral bevel and hypoid gears and pinions, these new Gleason machines afford more accurate control than was ever before possible in other machines. The end result —consistent, highly refined tooth surfaces which deliver the ultimate in smooth, quiet running drives.

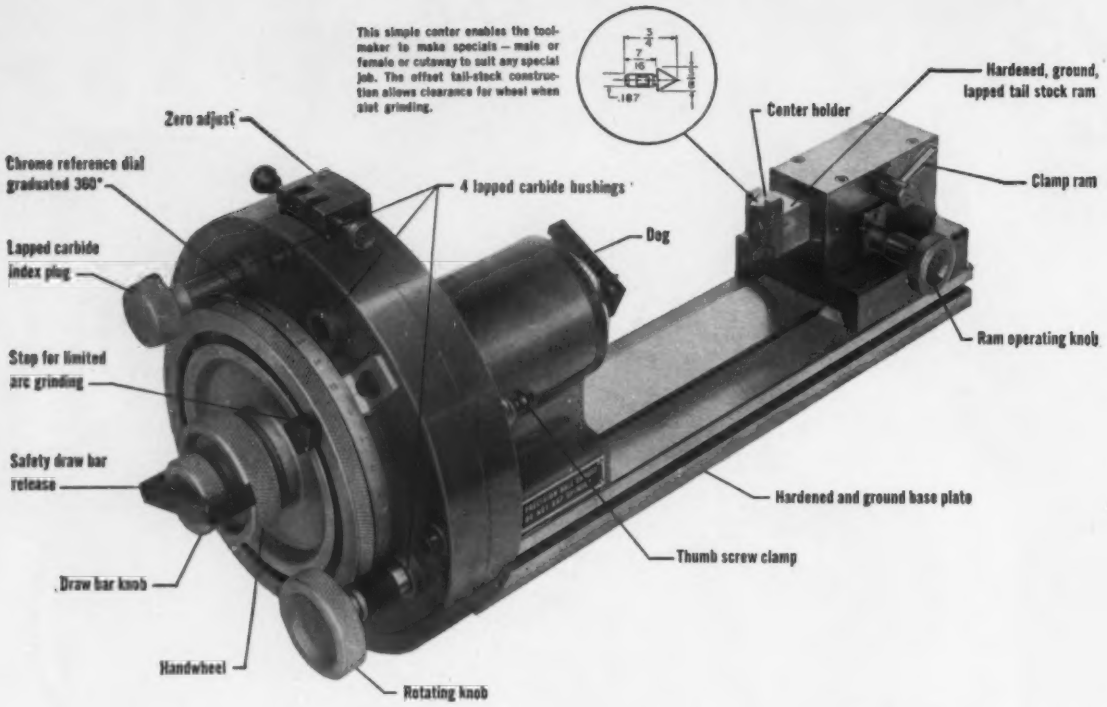
The Gleason 503 Hypoid Lapper employs an entirely new lapping concept . . . SPC (Swing Pinion Cone). While gear and pinion are rotating together in a flow of lapping compound, the pinion head automatically and continually swings about a vertical axis which passes through the center of the tooth mesh; reciprocates along the pinion axis; and reciprocates along the gear axis. This three-way action laps the entire surface of each tooth from heel to toe. All machine motions and lapping times are separately controlled for drive and coast sides . . . also, machine may be set for extra lapping time at heel or toe if desired. Positive control of backlash, brake load, and lapping motions assure accurate product duplication from machine to machine . . . from job to job. This greater flexibility, combined with the ease of set-up and extreme accuracy of the 503, make it superior to previous lapping machines. The 503 handles gears up to 10½" diameter of any pitch.

The Gleason 502 Hypoid Tester is a companion machine to the 503 Lapper . . . simulates the SPC motions for accurately soft testing, matching, and final testing. Can also be run at spindle speeds up to 4000 rpm to approximate actual vehicle speeds. Handles bevel and hypoid gears up to 10½" O.D.

For full information write Gleason Works, 1000 University Ave., Rochester 3, N. Y.

GLEASON

For more data, circle this page number on Readers' Service Card


This simple center enables the toolmaker to make specials — male or female or cutaway to suit any special job. The offset tail-stock construction allows clearance for wheel when slot grinding.
Zero adjust
Chrome reference dial graduated 360°
Lapped carbide index plug
Stop for limited arc grinding
Safety draw bar release
Draw bar knob
Handwheel
Rotating knob
4 lapped carbide bushings
Dog
Center holder
Hardened, ground, lapped tail stock ram
Clamp ram
Ram operating knob
Hardened and ground base plate
Thumb screw clamp

Save time, money and effort with the practical

MOORE PRECISION INDEX CENTER

The versatile Moore Index Center is a handy precision tool with tolerances that compare to the reputable Moore Measuring Machine. It is an instrument that will improve the facilities of any toolroom, or precision parts maker, when applied to:

1. Inspection of work on centers.
2. Jig boring, milling, and jig grinding work on centers.
3. Form grinding—spiders, splined punches, gear die punches and dies, sectional parts of dies where revolving the part on centers or in a spindle is necessary.

To give you an idea of how it achieves peak precision, and gets its work done quickly, examine the following Moore Index Center's special features:

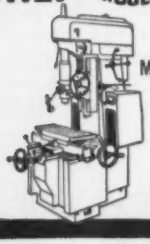
1. Special ball construction spindle; lapped-fit, 192 balls with ±.000005" (5 millionths) tolerance under load. Runs true to .000015" (15 millionths) T.I.R.
2. Lapped Carbide Index Plug and 4 lapped-fit carbide Plug-in-Stations, 0°, 45°, 90°, 180°*.
   24-hole hardened and jig ground index plate accuracy of spacing ±5 sec.
3. Accurately adjustable tail stock. Center line-up is maintained with lapped-fit ram movement of center.
4. Headstock uses "Moore Shank."
5. Sealed against dirt, it can also be used in wet grinding.

**Extra plug-in-station allows the user to turn his workpiece exactly 180° at any time to get his cut on dead center. It can also be used to re-orient for a different set of angles on the same workpiece.*

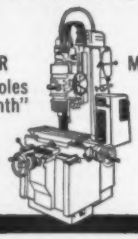
Write today for illustrated folder giving details, including specifications—

Moore Special Tool Co., Inc., 734 Union Avenue, Bridgeport 7, Connecticut

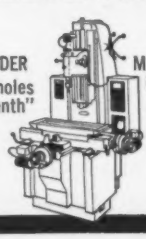
ONLY MOORE TOOLS CAN OFFER THIS COMPLETE PACKAGE OF PRECISION



MOORE No. 3 JIG BORER
Locates and bores holes to less than a "tenth"



MOORE No. 3 JIG GRINDER
Locates and grinds holes to less than a "tenth"



MOORE UNIVERSAL MEASURING MACHINE
Measures to one-third of a "tenth"

MOORE ROTARY TABLE
Divides the circle to less than 2 sec.

You don't have to baby it—Ledloy® steel actually performs at its highest efficiency when you really push it! ■ Take a tip from the many shops getting amazing results with this go-the-limit steel. Increased machinability, higher speeds and feeds, reduced tool wear with greater production per tool change—all these advantages are yours—if you push Ledloy steels. ■ Inland pioneered in the making of leaded steels—has the solid background that means dependable recommendations for your kind of operation and your specific product. Be sure the leaded steels you use are Inland Ledloy steels—the result of more than 20 years of research, development and continuous production. Ledloy steels are available from your Cold Drawer or your local Steel Service Center. Send for "Properties of Ledloy Steels," an informative booklet Inland will be glad to mail at your request.

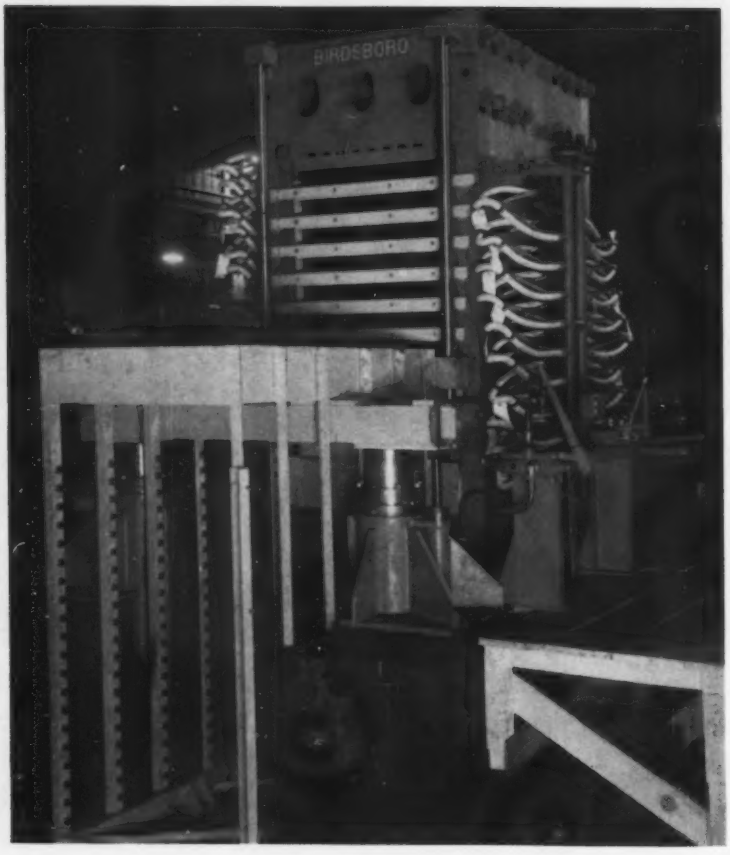
LEDLOY® STEELS CAN TAKE IT!

the world's most machinable steels **INLAND STEEL COMPANY** INLAND®

30 West Monroe Street • Chicago 3, Illinois

Unique laminating press elevator shoots production UP, costs DOWN

BIRDSBORO HYDRAULIC



Birdsboro platen press has multiple-opening elevator to speed loading, pressing and unloading.

If you're looking for ways to increase laminating production and profits, this Birdsboro steam platen press is a good place to begin. The 2000-ton hydraulic unit contains a unique multiple-opening elevator. From it, the single operator loads every other opening *during the pressing cycle.* When the press is opened, he unloads the pressed products . . . and reloads the press by advancing the elevator one position only.

Reduced time between pressing cycles and lowered labor costs are two specific advantages this combination delivers to laminators. Just write: *Sales and Engineering Departments:* Reading, Pa. *Manufacturing Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

HP 50-61

BIRDSBORO CORPORATION BIRDSBORO, PENNSYLVANIA

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • ROLLS • ELECTRIC STEEL CASTINGS: Carbon, Low Alloy and STAINLESS STEEL

DIVISIONS: MIRAWAL DIVISION • CHEMICAL MACHINERY DIVISION

WE'RE PUTTING OUR MONEY WHERE OUR MOUTH IS!

WITH A 90-DAY MONEY-BACK GUARANTEE ON THE NEW PRATT & WHITNEY TAPE-O-MATIC DRILL

$8,595

1½ HP. Big 30"x 20" table.
Simultaneous positioning of both axes.
(3 HP. optional at extra cost.)

NOW! FOR THE FIRST TIME A NUMERICALLY CONTROLLED DRILL FOR ONLY $8,595 GUARANTEED TO REDUCE YOUR DRILLING COSTS

At last . . . a drill with the finest, transistorized, numerical-control system available for only $8,595 . . . because P&W brings mass production to the machine tool industry for the first time . . . yet maintains the 100-year tradition of P&W quality.

The TAPE-O-MATIC enables **you** to benefit from numerical control . . . to gain a vitally-needed, important competitive edge.

WE BELIEVE IN THIS NEW DRILL SO STRONGLY THAT WE OFFER:

1 90-DAY, MONEY-BACK GUARANTEE. If by 90 days after purchase, this drill has not reduced your drilling costs, return it for refund, less transportation costs.

2 5-YEAR WARRANTY. We fully warrant the TAPE-O-MATIC drill against defective parts and workmanship for 5 years from date of purchase.

3 UNIQUE TERMS. You can buy TAPE-O-MATIC using our exclusive Trade-in Plan. You can purchase the drill outright, lease it, or lease it with option to buy. ONE PER CENT CASH DISCOUNT FOR PAYMENT IN 10 DAYS.

Call collect . . . your local Pratt & Whitney representative, now! Or write to: Paul N. Stanton, Vice President Marketing; Pratt & Whitney Co., Inc.; Charter Oak Blvd.; West Hartford, Conn.

PRATT & WHITNEY
A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY
Machine Tools / Cutting Tools / Gages

HEADQUARTERS FOR AMERICA'S WAR AGAINST OBSOLESCENCE

with the Texaco "Cleartex Cure" you can

DECREASE REJECTS AS MUCH AS 22%

Diluted cutting oil in automatics can mean a high reject rate. Read why a "Cleartex Cure" ends this dilution problem forever... keeps tool sharp... assures dimensionally accurate work—and reduces rejects as much as 22%.

In spite of precautions, lube oil leaks into the cutting oil sumps of up to 70% of all automatics. Diluted cutting oil not only piles up rejects, but also means shortened tool life, more downtime and substantial discarded cutting oil losses.

How a "Cleartex Cure" works. A "Cleartex Cure" stops this dilution problem. Your reject rate can drop by 22%. Here's why: Cleartex Oil—heart of a "Cleartex Cure"—is used in *both* cutting and lubricating oil sumps. It works as a hydraulic oil, too. Cutting oil strength is always full—regardless of leakage. Because of minimized losses and increased production, *you actually slash per-piece production costs as much as 40%.*

How to take a "Cleartex Cure." Getting the full benefits of a "Cleartex Cure" is easy. An experienced Texaco engineer will survey your automatic set-up. He'll tell you which machines will benefit from Cleartex. Our illustrated booklet, "Cleartex in Automatic Screw Machines," spells out the benefits of a "Cleartex Cure" in detail.

To get your copy, contact the nearest of more than 2,300 plants distributing Texaco Products, or write:

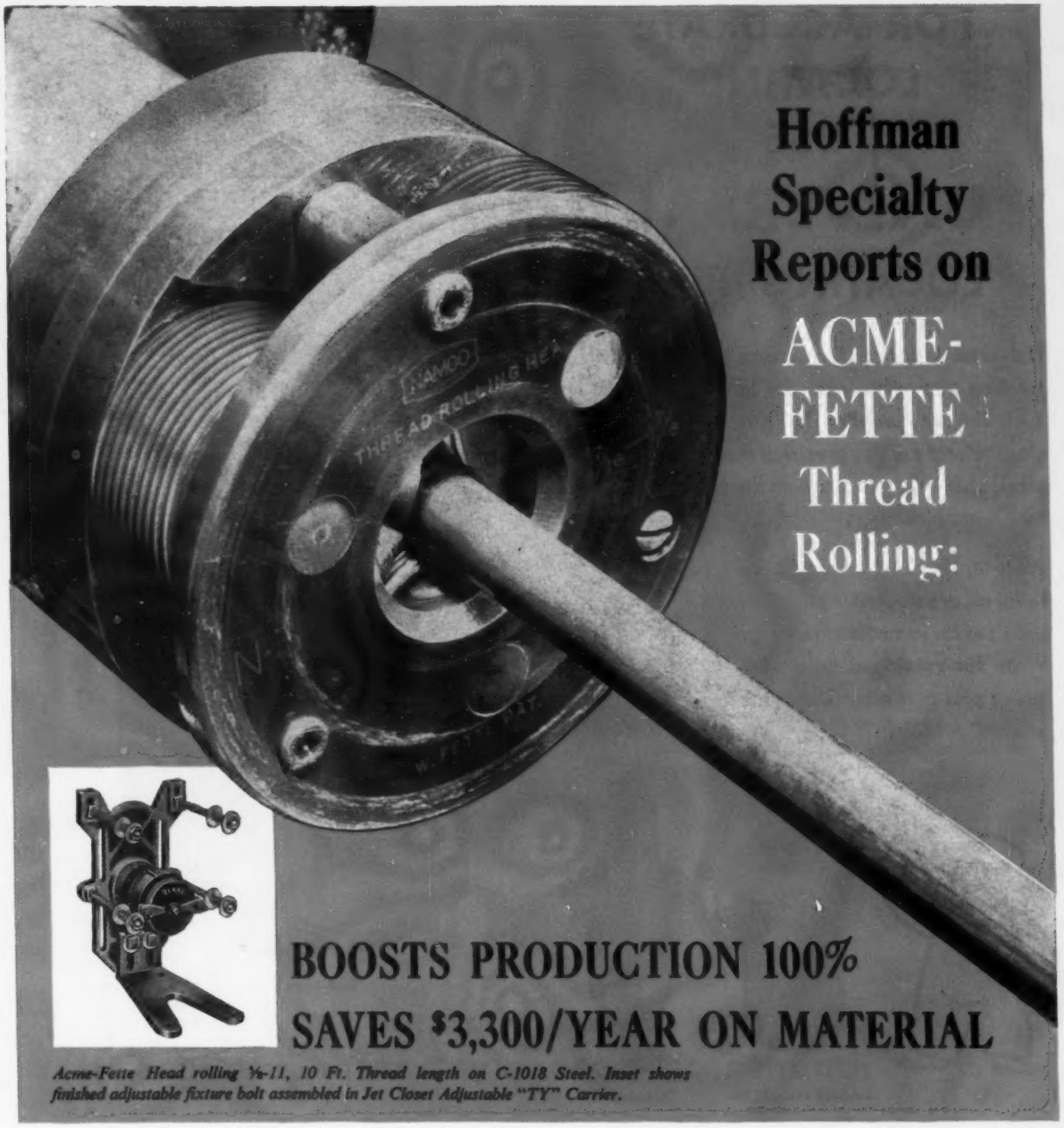
Texaco Inc., 135 East 42nd Street, New York 17, N. Y. Dept. MA-121.

TUNE IN: HUNTLEY-BRINKLEY REPORT, MON. THROUGH FRI.-NBC-TV

TEXACO

Throughout the United States

Canada • Latin America • West Africa



Acme-Fette Head rolling ⅜-11, 10 Ft. Thread length on C-1018 Steel. Inset shows finished adjustable fixture bolt assembled in Jet Closet Adjustable "TY" Carrier.

"Doubled production . . . saved us $3,300 on material alone . . . rolled over sixteen *miles* of thread with same set of rolls . . . produced stronger, more easily-assembled threads with finer finishes . . ." This is the Blake Division of Hoffman Specialty Manufacturing Corporation describing a year's operation with an Acme-Fette N-3 Self-Opening Thread Rolling Head. Such superior performance is easily explained: Because the Acme-Fette Head generates the thread progressively from the front of the rolls, metal flows to the thread's full depth eliminating broken grain structure and cratering at the thread crest. The result is a thread with a high grade burnished surface, remarkably resistant to wear and corrosion. And, Acme-Fette Heads roll any parallel or tapered thread from 1/16" to 2" up to *5 times faster* than thread cutting tools. Get full details. Send for Bulletin NAF-57A.

ROLLED THREADS ARE BEST... ACME-FETTE'S BEST FOR ROLLING

National Acme

THE NATIONAL ACME COMPANY
179 E. 131st STREET
CLEVELAND 8, OHIO

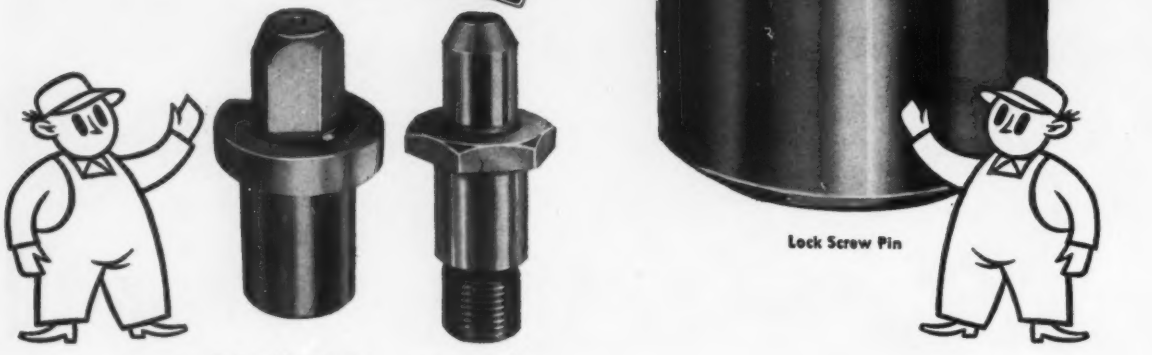
Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

For more data, circle this page number on Readers' Service Card

FOR ACCURATE LOCATING USE UNIVERSAL LOCATING PINS

Universal Locating Pins assure quick, accurate locating throughout even the longest production runs. They're hardened and ground to extremely close tolerances . . . precision made to give long service life for much less than the cost of ordinary tool-room pins.

Press fit, threaded or lock-screw types, round or relieved, are stocked in all standard sizes for immediate delivery. Write for catalog detailing locating pins plus other Universal production tools.



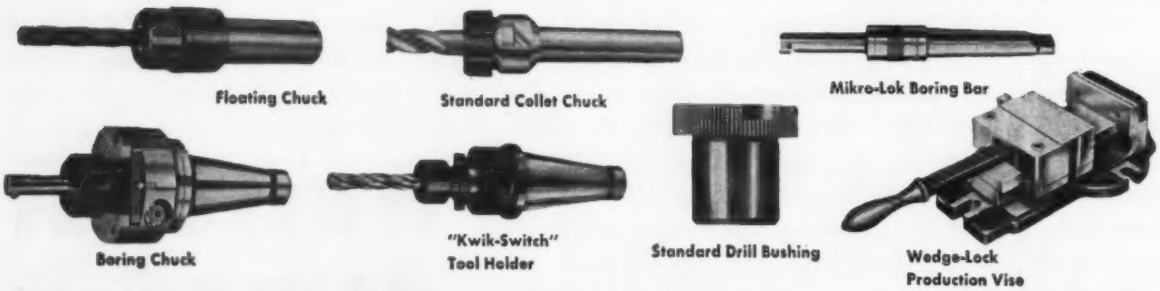
Lock Screw Pin

Relieved Press-Fit Pin

Threaded Pin

212

OTHER PRECISION-BUILT COST SAVING UNIVERSAL PRODUCTION TOOLS



Floating Chuck

Standard Collet Chuck

Mikro-Lok Boring Bar

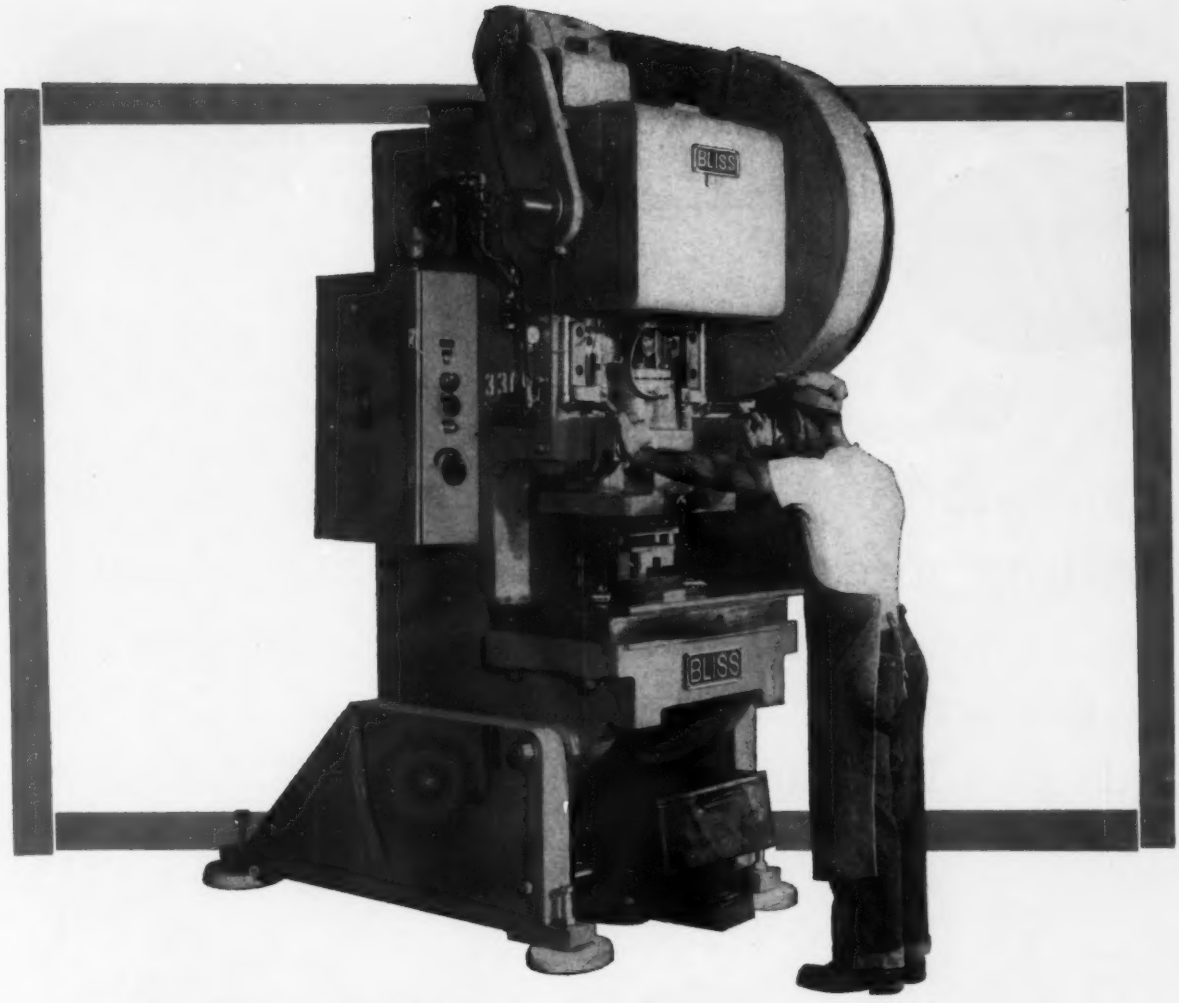
Boring Chuck

"Kwik-Switch" Tool Holder

Standard Drill Bushing

Wedge-Lock Production Vise

UNIVERSAL ENGINEERING COMPANY, FRANKENMUTH 2, MICHIGAN



DEPENDABILITY...

that pours out stampings in an uninterrupted stream, day after month

Bliss new Big "C" inclinables are already enhancing the acknowledged Bliss reputation for reliable operation under all kinds of pressroom conditions. Big "C's" are the strongest, sturdiest made: brawny beauties that minimize deflection and can run at twice their rated speeds with ease. Consider the four new Bliss C-60's at American Seating Company, Grand Rapids, Michigan. They blank, pierce, draw, perforate, punch, trim, form, and notch in a wide variety of strenuous single-tripping operations. American Seating can't tolerate frequent downtime for repairs. It doesn't have to with the Big "C's".

Add to this: extra die space ... extra large openings in bed and frame ... precision-forged crankshafts ... high quality, compact combination controls ... semi- or fully-automatic oil lubrication ... bronze ball seats ... lamina bronze gibs ... mechanical or air clutches ... geared or non-geared designs ... powered unsticking device. Bliss Big "C's", dollar for dollar, are your smartest buy in inclinables today. For full details, write for our full-color catalog. It's yours for the asking.

BLISS is more than a name ... it's a guarantee

E. W. BLISS COMPANY • Press Division • Hastings, Mich.

BLISS SINCE 1857 ®

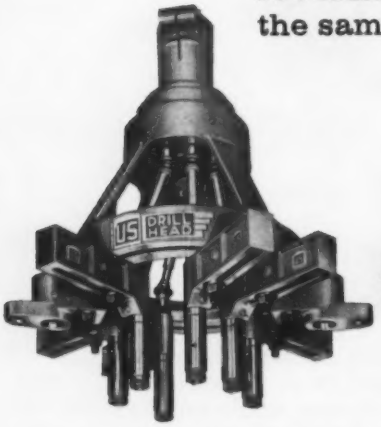
PRESSES • ROLLING MILLS • ROLLS • CONTAINER MACHINERY • CONTRACT MFG. • PUBLIC SAFETY

For more data, circle this page number on Readers' Service Card

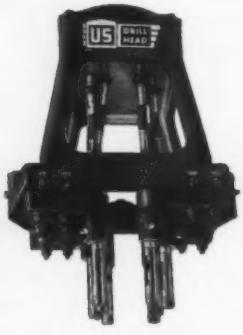
Quick-change deal...

or production runs... drilling only or drilling and tapping*... you can't beat the profit-making performance designed and built into universal adjustable **U.S. DRILL HEADS**

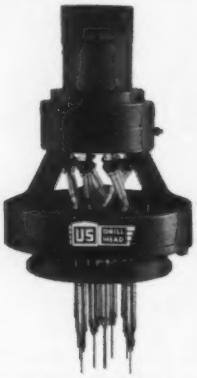
*When your drilling machine has a reversing spindle, you can drill and tap the same hole pattern with one head



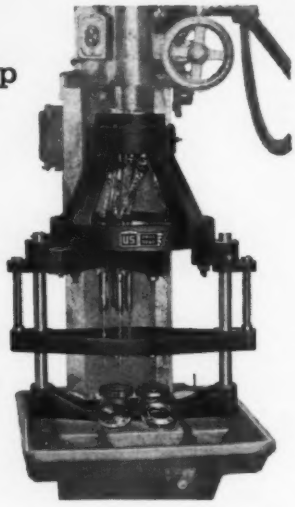
Style U Heads are built in 8 standard models — positive all-gear drive with shaved gears, antifriction bearings, and neoprene covered, lubricated quick-change joints—smooth, quiet, accurate.



Special head designs for single-purpose machines afford the flexibility of U. S. Drill Head's universal drives.



Slip Spindle Plates, used in place of the adjustable brackets, may be jig-bored to drill more than one pattern of holes.



Holding fixtures with guide bushing plates may be used for drilling two different workpieces at the same time, or to accommodate different hole patterns with a minimum of fixtures and setups. Guide bars maintain alignment.

US DRILL HEAD

Adjustable and Fixed Center Multiple Drilling Heads.
Individual Lead Screw Multiple Tapping Heads.

UNITED STATES DRILL HEAD CO.

5298 RIVER ROAD • CINCINNATI 33, OHIO

Ask for Catalog AD-57, or send specifications of your requirements.

for

INSPECTION

and

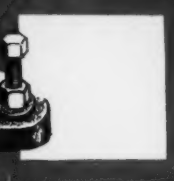
QUALITY CONTROL

you can't beat

MICRO-POISE

MODEL 6780 BALANCING MACHINE

You can't beat its versatility in production either. Besides quick and easy adaptation to a wide variety of work, drill or welding attachments allow on-machine correction in production applications.



MICRO-POISE ENGINEERING & SALES CO.

Balancing Engineers

14851 GRAND RIVER AVENUE, DETROIT 27, MICHIGAN • Telephone: VErmont 8-1134 (Long Distance Area 313)

For more data, circle this page number on Readers' Service Card

THE PIPE MACHINERY COMPANY

MANUFACTURERS OF

PIPE FINISHING MACHINERY, (THREADING-FACING) AUTOMATIC HANDLING TABLES
A.P.I. RECEDING DIES & TAPS, CHASERS AND CUTTING TOOLS
GAGES, (STANDARD AND SPECIAL)

QUOTA

29100 LAKELAND
WICKLIFFE, O

To Martin & Hay In
4692 Maine
Chicago, I

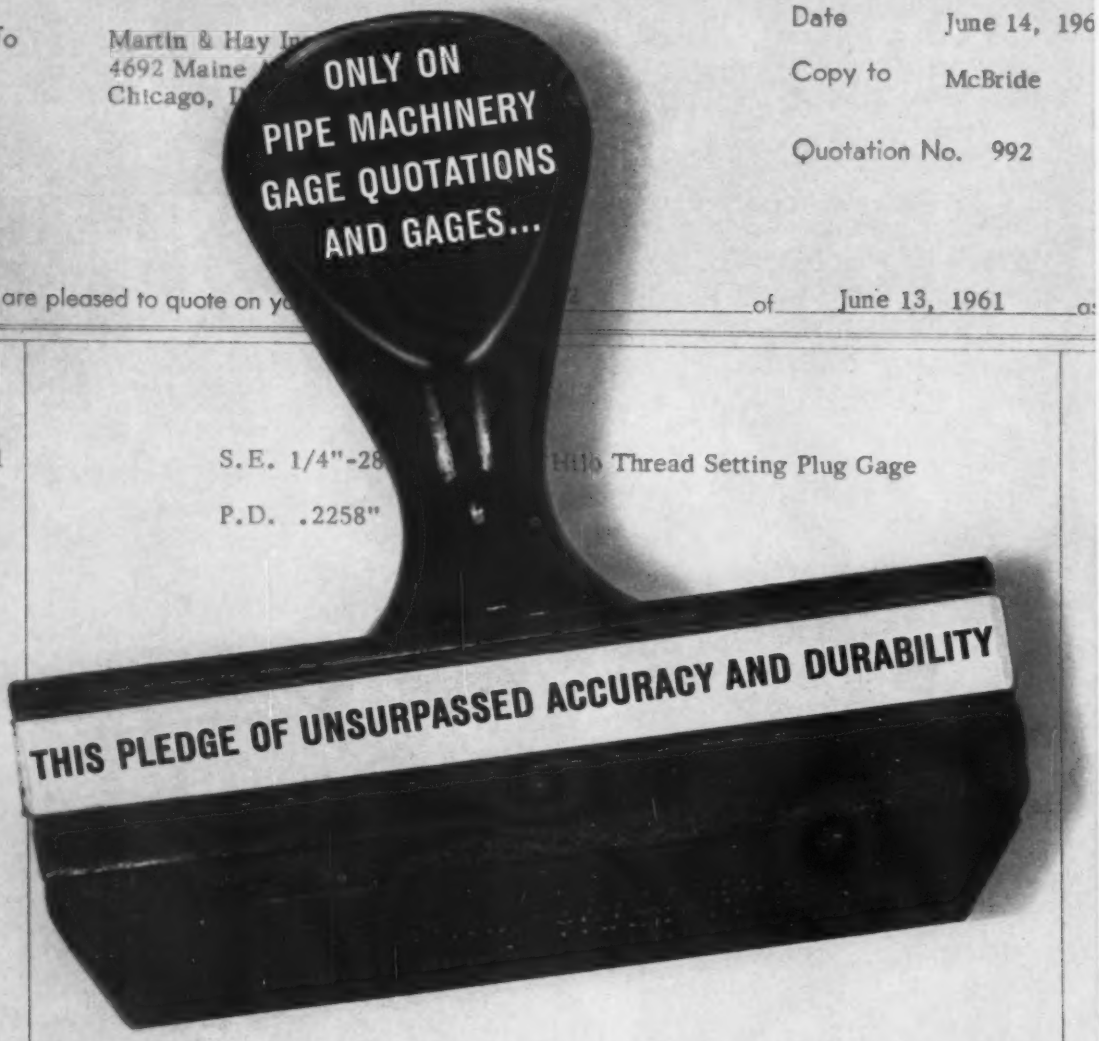
Date June 14, 196

Copy to McBride

Quotation No. 992

We are pleased to quote on yo 2 of June 13, 1961 as

1	S.E. 1/4"-28 Hilb Thread Setting Plug Gage P.D. .2258"	



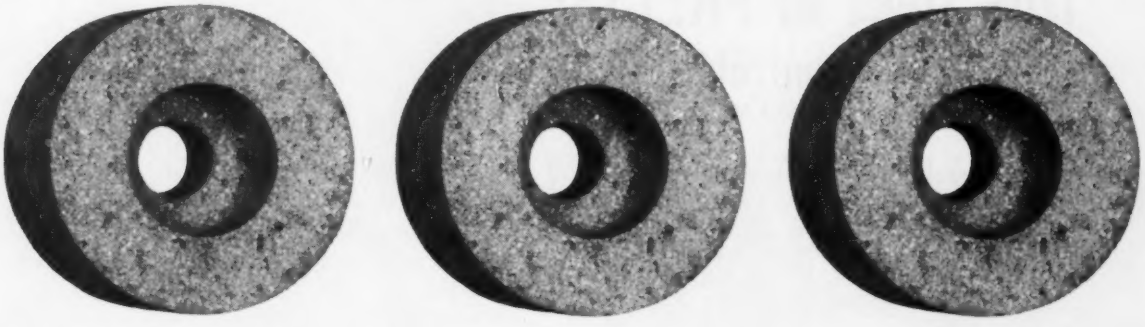
"Gages quoted on basis of furnishing rings lapped with a plug lap, and plugs lapped with a ring lap, to remove soft grinding skin, fat end thread, drunken thread, grinding chatter, and to produce a low micro finish. This operation is necessary to insure gage accuracy and long life. All gages will be stabilized by deep freezing to insure dimensional stability.

Lead error, including drunkenness, shall not be greater than lead tolerance shown in H-28 handbook."

For further details on our complete line of high quality gages write us on your company letterhead today.

THE PIPE MACHINERY COMPANY • 29100 Lakeland Boulevard • Wickliffe, Ohio • Greater Cleveland

POSITIVE DUPLICATION—EVERY TIME!



Each one of these kernels of corn has positive duplication built into it, just as have these internal wheels, and *all* CINCINNATI Ⓟ° GRINDING WHEELS. There are good reasons for this Ⓟ dependability . . . 36 good reasons.

FAMOUS, UNIQUE PROCESS

Three dozen unvarying quality controls govern every step of the famous Cincinnati Ⓟ manufacturing process, unique in the industry.

For example, the atmosphere of the mold room is *climate controlled* with conditions of temperature and humidity that *remain the same* from hour to hour, from day to day, from year to year!

RESULT: UNSURPASSED UNIFORMITY

This extraordinary attention to manufacturing detail results in wheels of unsurpassed uniformity. You can reorder CINCINNATI WHEELS with confidence, because they give you the same good job time after time. You use fewer wheels because Ⓟ wheels last longer.

CALL CINCINNATI TODAY

Factory trained by the Cincinnati Milling Machine Company, our grinding specialists are available to you for consultation on all your grinding problems. Call your CINCINNATI GRINDING WHEELS Distributor, or contact us direct, Cincinnati Milling Products Division, Cincinnati 9, Ohio.

Ⓟ POSITIVE DUPLICATION

CINCINNATI°
GRINDING WHEELS

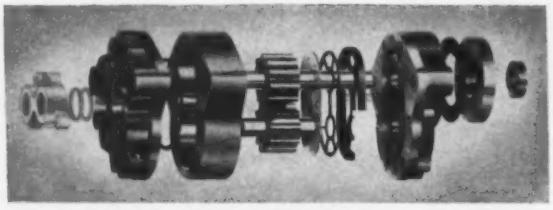
°Trade Mark Reg. U.S. Pat. Off.

A PRODUCTION-PROVED PRODUCT OF THE CINCINNATI MILLING MACHINE CO.

For more data, circle this page number on Readers' Service Card

Precisionaire gages qualify parts and tolerances to tenths on as many as ten simultaneous dimension readings.

This fleet of PRECISIONAIRE® gages... controls Cessna quality at the machines



Six models of this Cessna hydraulic pump, used on farm and construction equipment, are gaged during production.

Honing machine operator checks valve body bore at 9 points at once, determines .0001" classifications.

"Without the proper type and quantity of gaging equipment, we never would have been able to produce such high quality hydraulic pumps, valves, and cylinders at such low relative costs," reports the Industrial Products Division of Cessna Aircraft Company.

Knowing that bad pumps correlate with lack of gaging equipment, Cessna has a complete set of gages for each model pump, ready to roll to the machines for quick setup and start of production. Thirty-five rolling gage cabinets, carrying more than 400 Precisionaire columns, are used in the production of these pumps.

All pump parts are produced to be completely interchangeable—there is no classifying or selective fitting. This results in minimum investment in parts inventory, a very rapid rate of assembly, and practically no reworks.

Interchangeable parts greatly simplify replacement problems. Inventory is at an irreducible minimum, service problems are negligible, and users are happy with the minimum maintenance and maximum performance of the pumps.

Write for The Cessna Story and Precisionaire Catalog SPG-160. The Sheffield Corporation, Dayton 1, Ohio.

The SHEFFIELD Corporation Dayton 1, Ohio

A subsidiary of The Bendix Corporation

Inspection Gages, Dimensional Control Instruments, Machine Controls, Automatic Gaging & Assembly Systems, Measuray® X-Ray Thickness Measuring, Crushtrue® & Multiform® Grinders, Cavitron® Ultrasonic Machine Tools, Press-Pacer® Transfer Units, Large Dies, Tooling, Contract Manufacturing.

Are you taking full advantage of

FREE ENTERPRISE

within your own business?

The privilege of buying new machinery and replacing old machinery and equipment is one of the healthiest opportunities afforded manufacturing management. It's an important advantage in the "freedom of operation" of your plant. There are other "outside" costs that affect profit margins. That's why it is important for management to take advantage of scientific equipment replacement programs. These programs assist management in compiling and analyzing all factors pertinent to profitable machinery and equipment buying. They reveal the proper time to replace obsolete equipment.

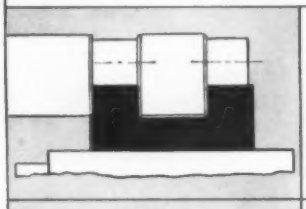
For more information showing how other manufacturers are using their programs, write for the illustrated book. Write to any one of the companies in this group.

Rockford Insert Group

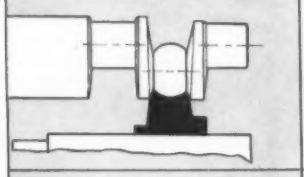
Keep gathering metal-working production ideas . . . be well informed when you replace machinery . . . .

Eccentric Forming on Greenlee Automatic Bar Machines

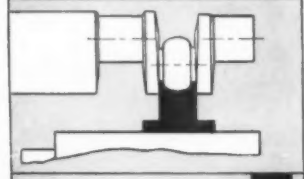
MACHINE . . . 1-5/8" — 6 Automatic Bar Machine
TOOLING . . . High Speed Steel
MATERIAL . . . B1112
STOCK SIZE . . . 1" round
TOOL SLIDE STROKE . . . 1-3/16" at .0042" feed
SPINDLE SPEED . . . 420 rpm 110 sfm
MACHINE TIME . . . 43 seconds
ESTIMATED GROSS PRODUCTION . . . 83 per hour



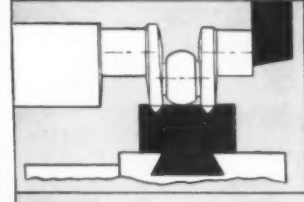
1. Rough eccentric form .550" diameter and 1/32" radius.



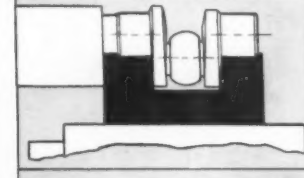
2. Rough eccentric form .643" spherical diameter, finish form inside tapered sides, and 1/32" radius.



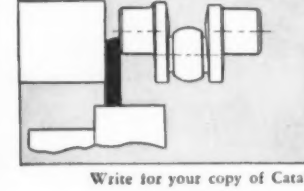
3. Finish eccentric form .643" spherical diameter and .023" radii.



4. Face end. Break corners on 1" diameters.



5. Finish eccentric form .550" diameter, outside tapered sides, 1/64" radii, chamfer 45° on ends, and break-down for cutoff.



6. Cut off.

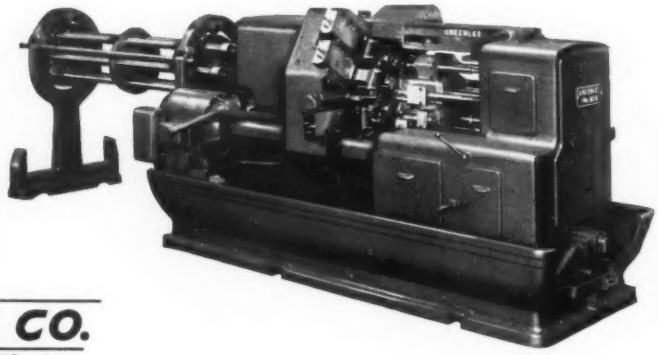
Write for your copy of Catalog A-405

PRODUCED WITHOUT COSTLY "SECOND OPERATION"

"Union Special" relies on GREENLEE versatility to cut production costs of multiple eccentric crankshaft

Standard Greenlee Automatic Bar Machines are extremely versatile. Union Special Machine Company, manufacturers of industrial sewing machines, utilizes this production versatility to machine the multiple eccentric crankshaft illustrated. The part is machined from 1" round B1112 stock and is held in standard concentric collets. Part is machined in 43 seconds giving a gross production output of 83 pieces an hour. Sequence of operations is shown at left.

Special eccentric forming attachments mounted in the first, second, third, and fifth forming slide positions, rough and finish form the two eccentric diameters. Greenlee Bar Automatics permit greater job versatility and assure added profits. See your Greenlee representative or send us a print of your problem-part.



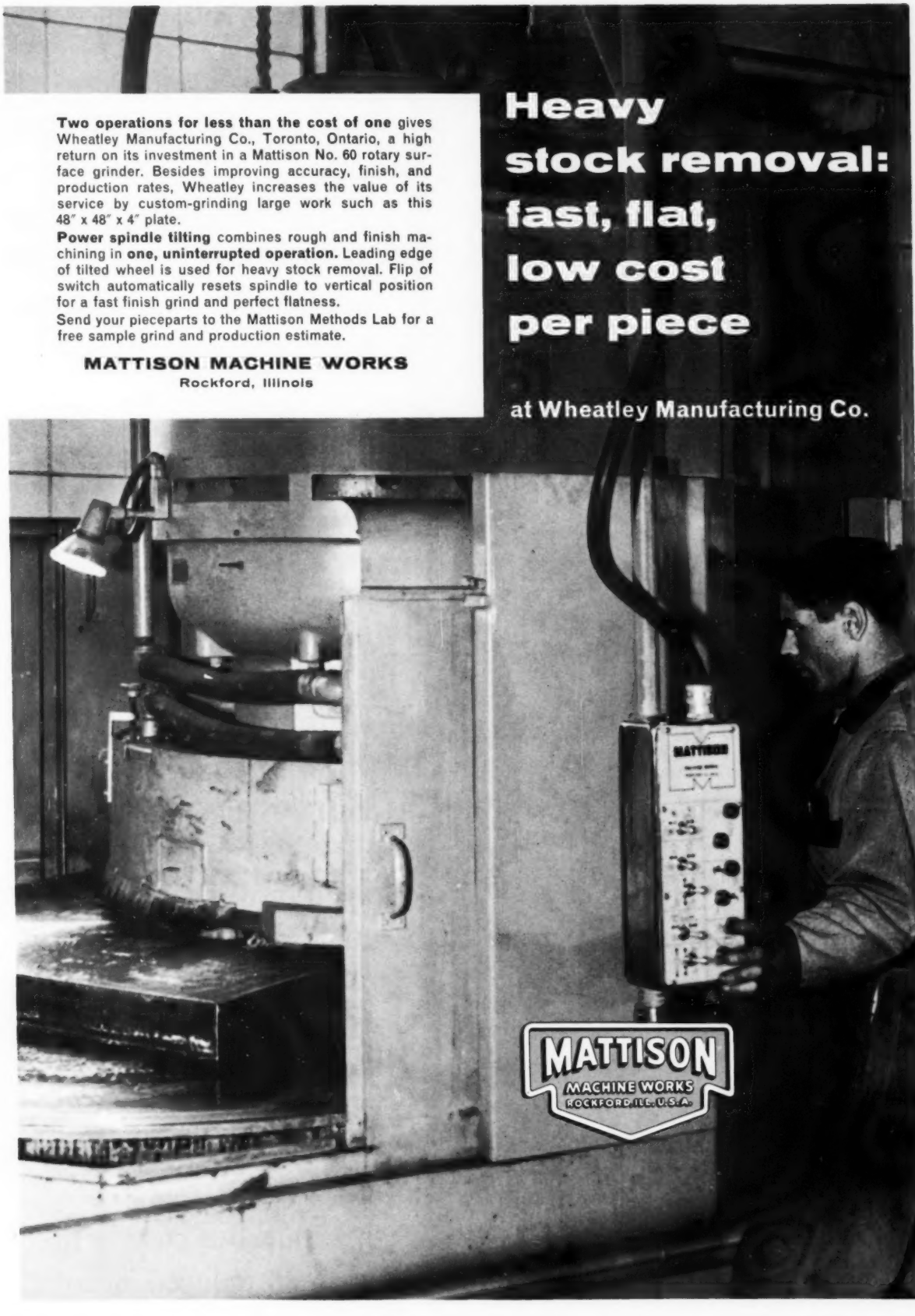
PRODUCTION MACHINERY

GREENLEE BROS. & CO.

Since 1863 — 1991 Mason Avenue ROCKFORD, ILL.

TRANSFER MACHINES • SPECIAL MACHINES • AUTOMATIC BAR MACHINES • WOODWORKING MACHINES AND TOOLS
DIE CASTING MACHINES • TRIM PRESSES • HYDRAULIC AND HAND TOOLS • COMMERCIAL CASTINGS

For more data circle No. 891 on Readers' Service Card.

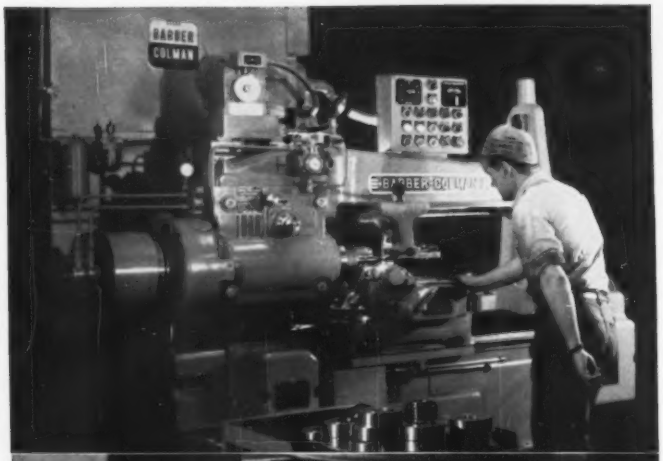


Two operations for less than the cost of one gives Wheatley Manufacturing Co., Toronto, Ontario, a high return on its investment in a Mattison No. 60 rotary surface grinder. Besides improving accuracy, finish, and production rates, Wheatley increases the value of its service by custom-grinding large work such as this 48″ x 48″ x 4″ plate.

Power spindle tilting combines rough and finish machining in **one, uninterrupted operation.** Leading edge of tilted wheel is used for heavy stock removal. Flip of switch automatically resets spindle to vertical position for a fast finish grind and perfect flatness.

Send your pieceparts to the Mattison Methods Lab for a free sample grind and production estimate.

MATTISON MACHINE WORKS
Rockford, Illinois



TOTAL JOB ANALYSIS multiplies savings over ordinary cost studies.

Your company can profit from this dual approach to cost reduction. At the Lockformer Co., Chicago manufacturer of roll forming machinery, hourly out-

365%

put of forming rolls (upper right) was increased from 8.6 to 40. A round figure gain of 365%! Other jobs (most of them short runs) showed similar gains. // First, Lockformer's hobs were redesigned to increase machine speed. The roll gear, for example, originally cut with a 2¾" single-thread hob at 204 rpm, now is cut with a triple-thread, 3¼" diam hob at 306 rpm. Feed is the same, but cutting time has been reduced. Second,

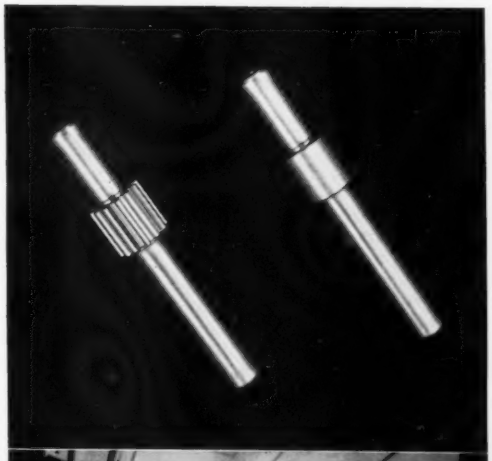
For more data circle No. 893 on Readers' Service Card.

CENTER OF MACHINE-TOOL EXCELLENCE **ROCKFORD, ILLINOIS, U.S.A.**

cycle time was trimmed by a Barber-Colman No. 16-16 MULTI-CYCLE machine. Combination power vertical feed and automatic cycling reduced approach distance. Rapid traverse of the workslide and hob carriage reduced noncutting time. To sum up– an automatic

INCREASE

cycling machine with complete general-purpose flexibility was combined with proper hob design to increase productivity 365%, and with better accuracy, finish, and tool life. // Take advantage of a Barber-Colman total job analysis to reduce your costs. A complete cost evaluation . . . developed from your gear prints and production requirements and backed by a machine demonstration in our TEST CENTER (right). Phone your Barber-Colman representative for details.



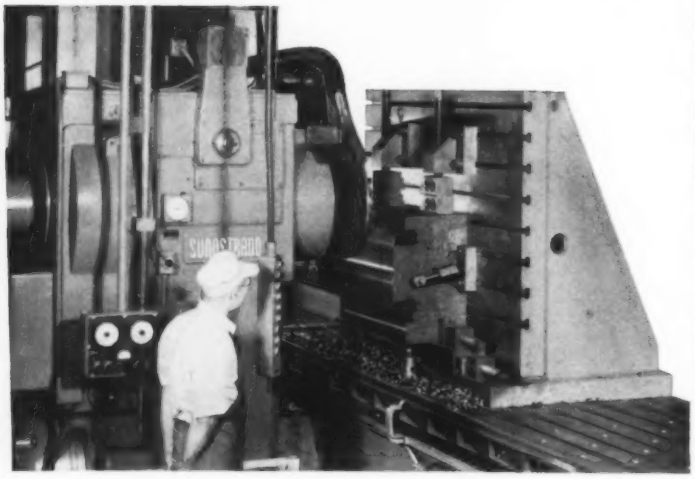
BARBER COLMAN

BARBER-COLMAN COMPANY

112 Loomis Street, Rockford, Illinois

RIGIDMIL

RIGIDITY...THE KEY TO SUCCESSFUL MILLING



It's easy to put horsepower into a milling machine, but can you deliver this horsepower to the tool without chatter, vibration, or accuracy-destroying deflection? The answer is "yes", with a Sundstrand Rigidmil.

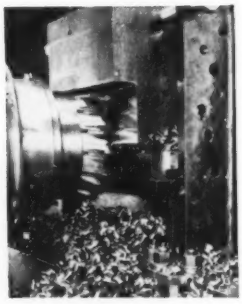
Sundstrand has a reputation for building extremely rigid precision machines — a reputation that is fulfilled to the maximum in its complete line of Rigidmils.

You can use the full horsepower that's built into the machine without any sacrifice in smoothness and accuracy of operation. You can take heavier cuts, run at higher speeds, and use larger diameter cutters. The result is greater production . . . plus longer tool life . . . plus greater accuracy . . . plus better finishes than would be possible with less rigid machines.

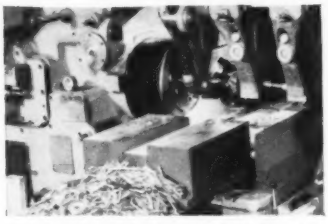
When you buy a Sundstrand Rigidmil, you get *more machine* — with the weight where it counts to set completely new standards of milling performance in your plant.

Ask for a Sundstrand "Engineered Production" analysis which evaluates your requirements from the standpoint of production, range and size of parts, types of milling operations, and the economics of the machine and the machining. Based on this study, Sundstrand engineers will recommend the machine that's best for the job — and best means most economical in the long run. Ask for complete information.

SUNDSTRAND RIGIDMIL RIGIDITY MAKES POSSIBLE CUTS LIKE THESE

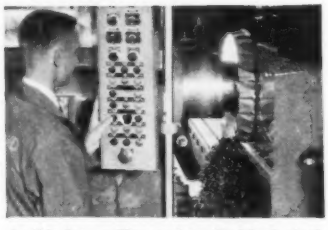


Ruff milling shank in steel die block. Cut is .400" deep by 5-1/2" wide taken with 10" dia. carbide cutter.



This cut in mild steel is 1-1/2" deep by 4" wide, taken with an HSS 8-1/2" dia. channeling cutter.

This slab milling cut on a steel forging is made with two 6" dia. x 6" wide helical HSS cutters. The cut is 1/8" deep by 12" wide.



In this face milling cut on die block steel a 14" dia. carbide face mill is shown in a cut 3/8" deep by 10" wide.

SUNDSTRAND

SUNDSTRAND MACHINE TOOL

Division of SUNDSTRAND CORPORATION
BELVIDERE, ILLINOIS

You'll see why Sundstrand Rigidmils do more work more accurately day after day when you study their design features in Bulletin No. 629-1. Ask for your copy today.

For more data circle No. 894 on Readers' Service Card.

MACHINES DESIGNED TO MEET YOUR NEEDS **ROCKFORD, ILLINOIS, U.S.A.**

QUALITY...TODAY'S DIFFERENCE BETWEEN PROFIT AND LOSS!

These are the days of the 12-month warranty . . . extended service guarantees! Never before has Quality been so important.

That's why we suggest you consider BarnesdriL Honing Machines for your surface finishing operations. Because of the quality inherent in these precision-made machines, they impart that "extra" touch of quality to your products at cost-cutting production speeds.

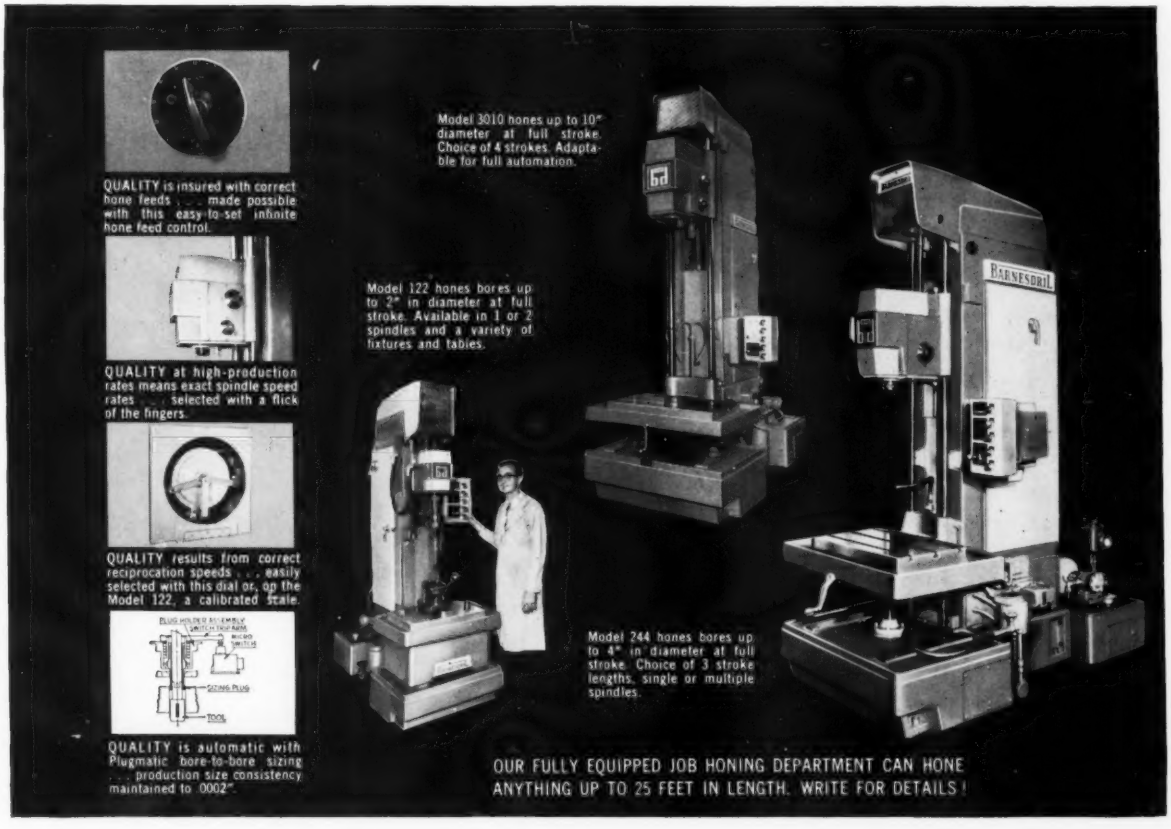
Our detailed story — backed by 35 years of specialization in honing — is yours free! Ask for catalog 200.

BARNESDRIL HONING MACHINES

Honing Machines/Production Units
Filtration Units/Drilling Machines

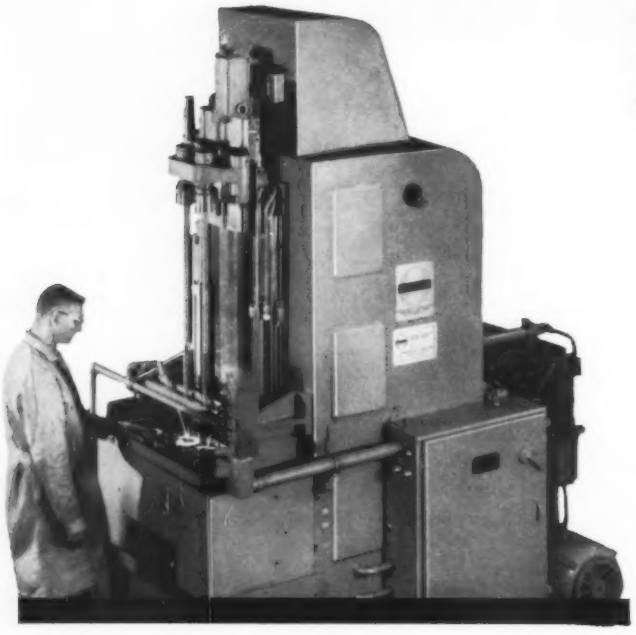
BARNES DRILL CO.

820 CHESTNUT STREET • ROCKFORD, ILLINOIS
DETROIT OFFICE • 13121 PURITAN AVENUE

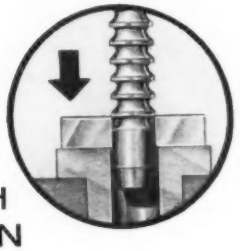

QUALITY is insured with correct hone feeds . . . made possible with this easy-to-set infinite hone feed control.
QUALITY at high-production rates means exact spindle speed rates . . . selected with a flick of the fingers.
QUALITY results from correct reciprocation speeds . . . easily selected with this dial or, on the Model 122, a calibrated scale.
QUALITY is automatic with Plugmatic bore-to-bore sizing . . . production size consistency maintained to .0002".
Model 3010 hones up to 10" diameter at full stroke. Choice of 4 strokes. Adaptable for full automation.
Model 122 hones bores up to 2" in diameter at full stroke. Available in 1 or 2 spindles and a variety of fixtures and tables.
Model 244 hones bores up to 4" in diameter at full stroke. Choice of 3 stroke lengths, single or multiple spindles.
OUR FULLY EQUIPPED JOB HONING DEPARTMENT CAN HONE ANYTHING UP TO 25 FEET IN LENGTH. WRITE FOR DETAILS!

CONVERTIBLE

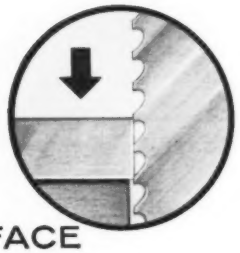
SUNDSTRAND-AMERICAN VERTICAL BROACHING MACHINES



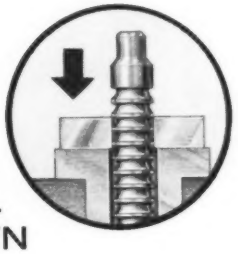
Unit construction simplifies change-over to these operations



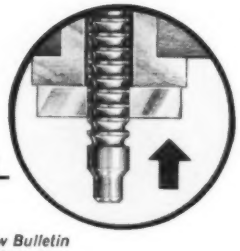
PUSH DOWN



SURFACE



PULL DOWN



PULL UP

At moderate cost — in a matter of hours — you can convert a basic Sundstrand-American vertical broaching machine to any of the arrangements illustrated.

Thus you can meet a variety of requirements with a single machine and changeover assemblies, or you can buy a machine for one type of operation today, confident that it will not be obsoleted if your requirements change tomorrow.

These new 4-way convertible broaching machines are built in both single and dual ram models. Capacities are 5, 10, 15, 25, 40, and 50 ton, with strokes from 30″ to 90″, depending on tonnage — 22 stroke tonnage combinations in all. All operations are from a pushbutton station.

Sundstrand backs these machines with an "Engineered Production" service which evaluates your requirements and offers all three elements essential to peak broaching performance:

1. *Correct broach tool design* — This logical first step in solving a broaching problem requires consideration of stock removal, length and width of cut, finish, tolerances, etc., so broach fixture and machine operate as a team.
2. *Specifying the right machine* — Production rate required, length and speed of stroke, floor space, and relationship with other production machinery are all considered before recommending the machine for a job.
3. *Efficient fixturing* — This vital third link in the production chain enables production schedules to be met even with inexperienced operators because fixtures are provided with the skills "built in."

For complete information, write today.

Ask for new Bulletin 633, describing in detail the basic machine units and conversion assemblies, machine design features, and optional accessories. Detailed dimensional data and specifications are given for all models. Write for your copy today.

SUNDSTRAND

SUNDSTRAND-AMERICAN BROACHING EQUIPMENT

SUNDSTRAND MACHINE TOOL

DIVISION OF SUNDSTRAND CORPORATION

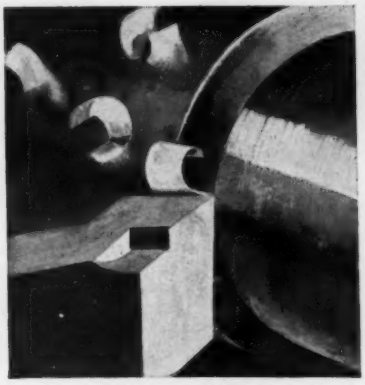
BELVIDERE, ILLINOIS

For more data circle No. 896 on Readers' Service Card.

MACHINES DESIGNED TO MEET YOUR NEEDS **ROCKFORD, ILLINOIS, U.S.A.**

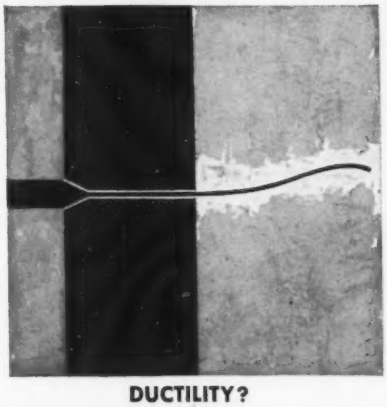
PRESSURE?

HEAT?

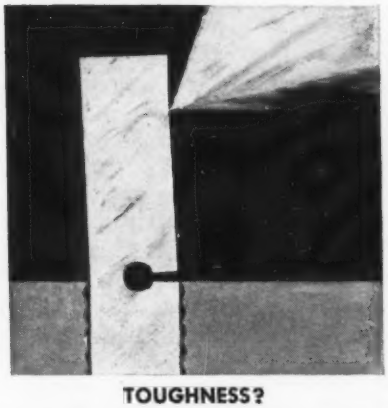


MACHINABILITY?

STRENGTH?



DUCTILITY?



TOUGHNESS?

What's your steel problem?

Rockets, automatic transmissions, landing gears, complex dies, chemical and oil-well equipment, atomic generators—all these and many more tough steel problems found their answers in Timken® fine alloy steel.

With over forty-five years of developing fine alloy steels and applying them to every conceivable industry and defense problem, Timken Company metallurgists are recognized experts. Whatever your problem, whatever combination of properties you need, you'll do better with Timken fine alloy steel. Your order is continually checked and rechecked from melt to shipping to fit your exact specifications. And you can have it in tube, bar, billet or wire form.

The next time you have a tough steel problem call in experts—Timken Company metallurgists. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN® FINE ALLOY STEEL

ON A GISHOLT SUPERFINISHER

MASTERLINE 81 Superfinisher

A single spindle vertical Superfinisher.

For flat, conical or spherical surfaces.

Superfinishing cycle is automatic—operator just loads and unloads.

Adapts to automatic handling . . . especially in-out conveyor systems.

Vertical design saves valuable floor space . . . simplifies addition to existing production lines.

The Model 81 is one of Gisholt's Superfinishers —ask Gisholt about the others.

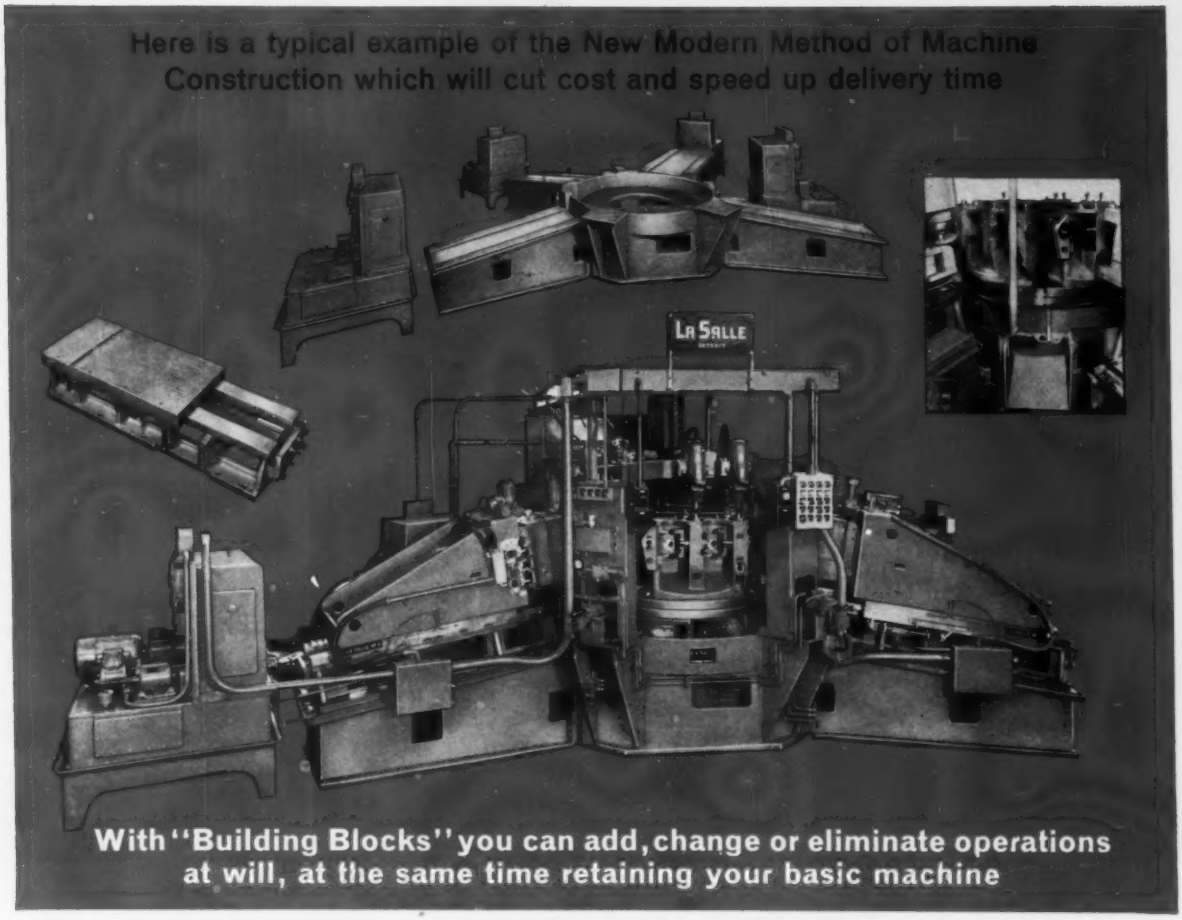
Flat, cylindrical, tapered and spherical surfaces can be *Superfinished* to specifications faster . . . at less cost. You can produce any controlled finish from 1 to 80 micro-inches rms *automatically*. In many cases you Superfinish directly after turning, boring or facing, without intermediate grinding. On other parts, you rough-grind and then Superfinish. Either way, you save initial investment, grinding wheel costs, production time, work-handling and floor space . . . and, you eliminate *skilled* labor! Write for Catalog 1169-C.

GISHOLT
MACHINE COMPANY
Madison 10, Wisconsin, U.S.A.

Turret Lathes • Automatic Lathes • Balancers • Superfinishers • Threading Lathes • Factory-Rebuilt Machines with New-Machine Guarantee

HAVE YOUR AUTOMATION MACHINE TOOLS BUILT BY La Salle FROM STANDARD BUILDING BLOCKS

ELIMINATE duplicate engineering • AVOID premature obsolescence
ELIMINATE pattern costs and machining time


Here is a typical example of the New Modern Method of Machine Construction which will cut cost and speed up delivery time
LA SALLE
With "Building Blocks" you can add, change or eliminate operations at will, at the same time retaining your basic machine

LaSalle—One of the Nations Larger machine tool builders has pioneered the way to a better Construction Method for all Machine Tools.

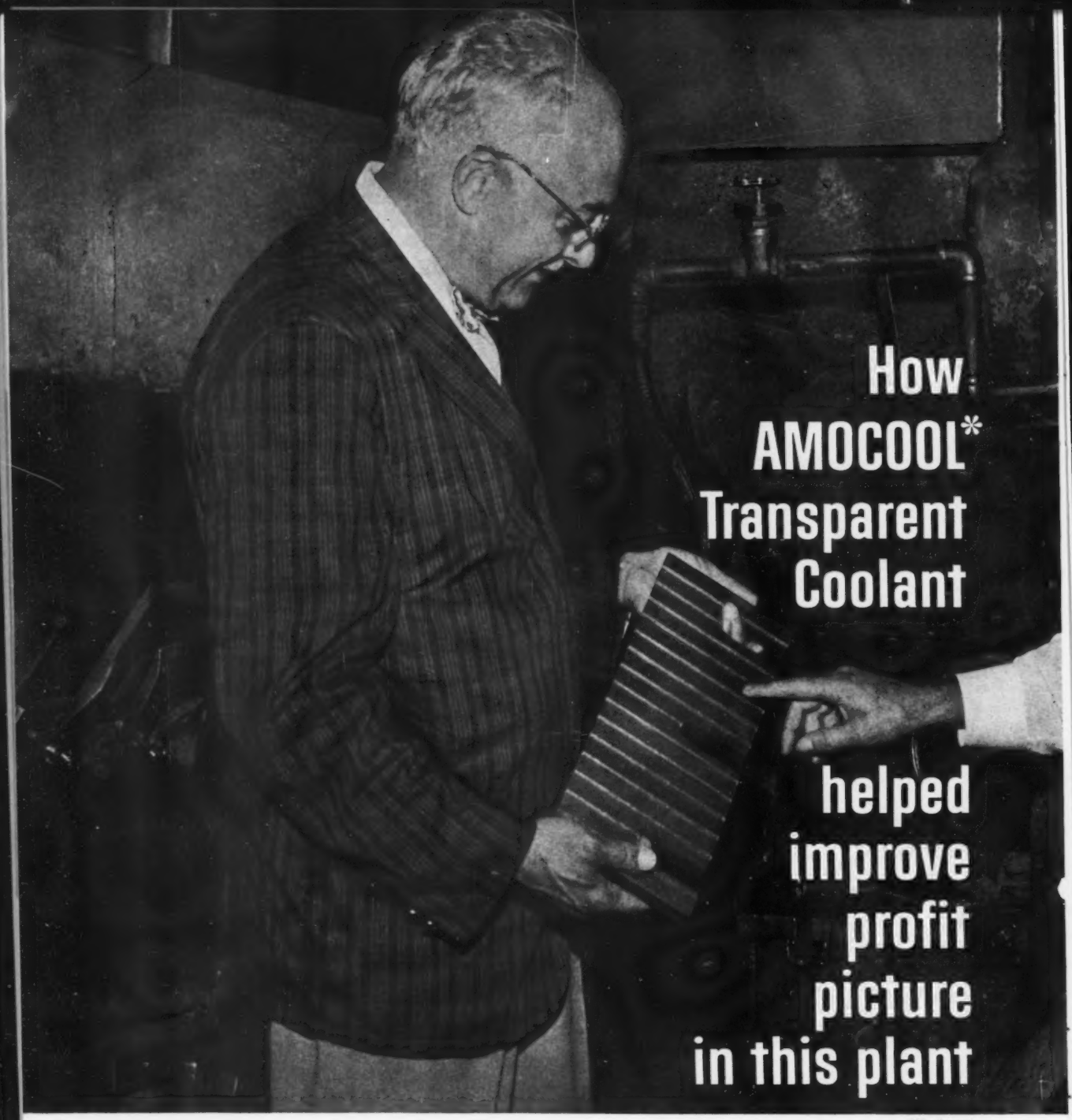
WRITE FOR BUILDING BLOCK CATALOG NO. 1.

La Salle machine tool, inc.

AUTOMATION ENGINEERS • SPECIAL MACHINE TOOLS

21535 Hoover Road Warren, Michigan

For more data, circle this page number on Readers' Service Card



How AMOCOOL* Transparent Coolant helped improve profit picture in this plant

*Trademark

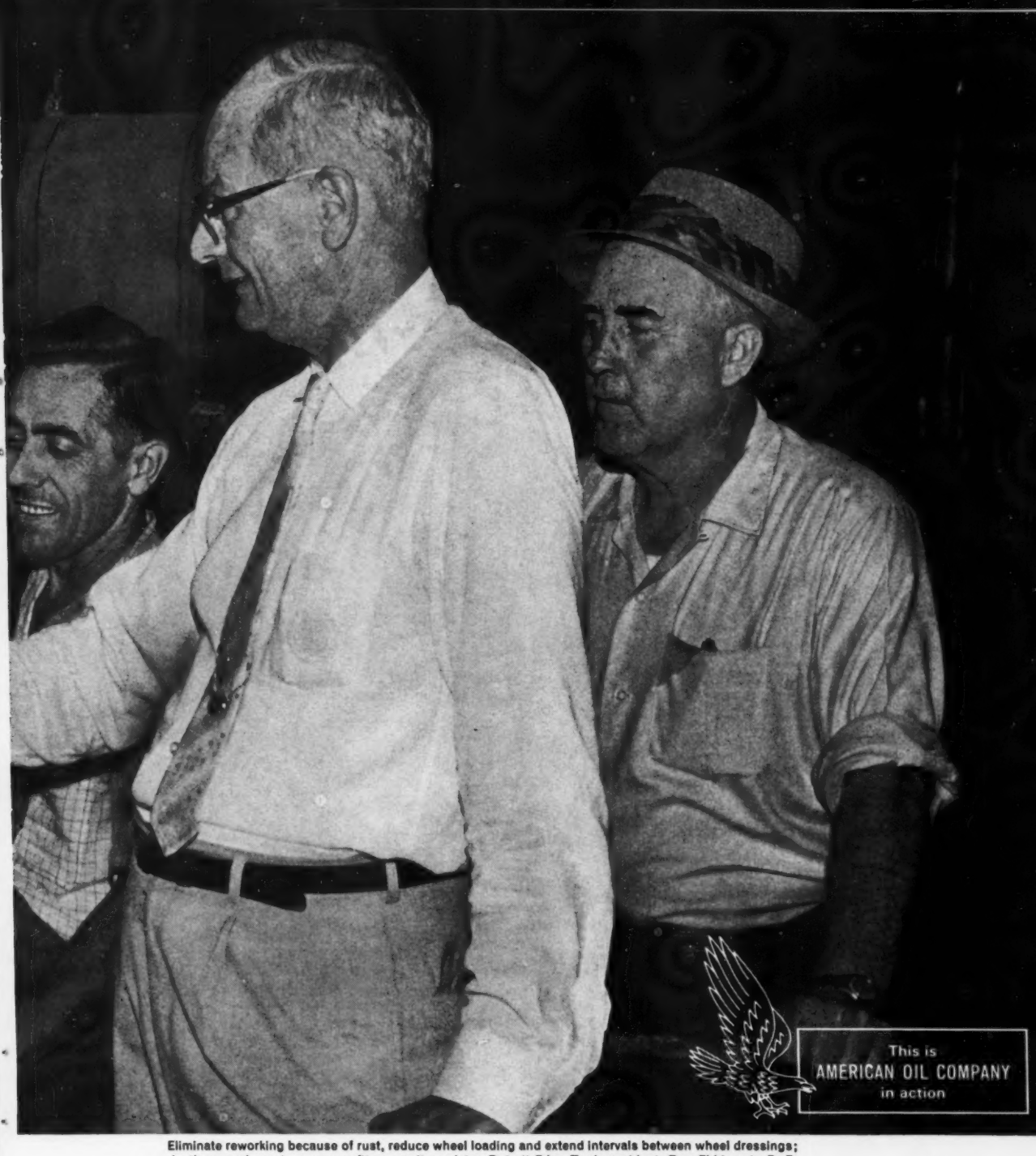
BY PAUL E. "PAPPY" STRATTON

About the Author. "Pappy" Stratton has been providing technical help on lubrication and metalworking problems to customers in the Detroit area for nearly all of the twenty-five years he has been working for the company. In addition to having this store of practical experience to help him, Pappy has completed the Company's Sales Engineering School.

• • •

By using a soap-base grinding compound, Detroit Edge Tool Company was getting excessive corrosion and rust on work and grinding machines. Oil vapor was collecting on machines and on the ceiling, causing dirty working conditions. Most important, high wheel loading was causing frequent down-time for wheel dressings.

We worked out a test program on AMOCOOL Transparent Coolant with the management. On our first test on one surface grinder, feed pressure was cut substantially while at the same time metal removal was increased.



Eliminate reworking because of rust, reduce wheel loading and extend intervals between wheel dressings; do these and you increase profit per unit, explains Detroit Edge Tool president, Dan Ebbing, to P. E. "Pappy" Stratton of American Oil. Plant manager, John Yonker (right) and Sam Vineh, operator, look on.

The cost of reworking parts to remove rust was eliminated. Time required to clean machines to get rid of the odor was cut in half. Less wheel loading and fewer wheel dressings have upped production and reduced costs. Our test program paid out in an improved profit picture. All grinding and drilling equipment has been converted to AMOCOOL Transparent Coolant.

* * *

Would you like this kind of technical help to assist you in improving profits? Get it by calling the American Oil Company office nearest you.

Quick facts about
AMOCOOL
Transparent Coolant

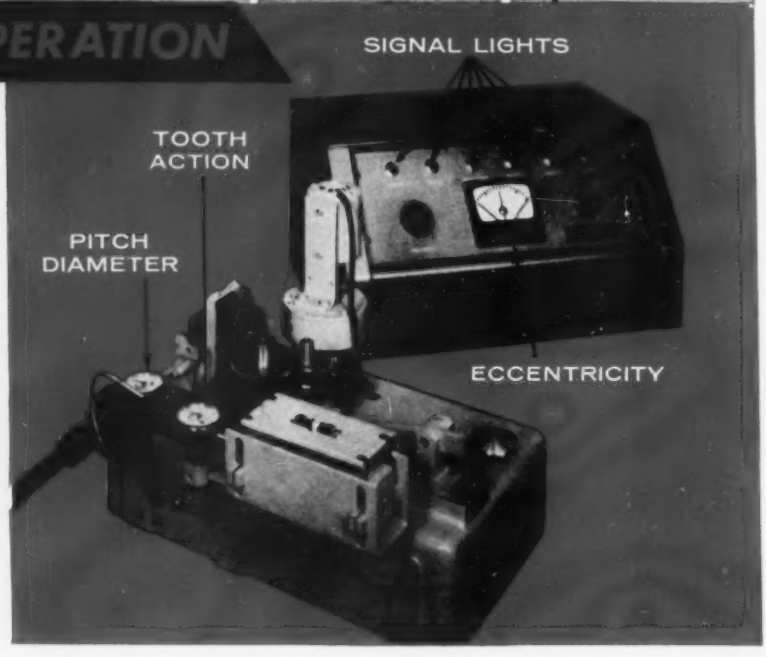
- Clear, transparent fluid
- Controls corrosion on work and machines
- All chemical. Does not support bacteria growth
- Unaffected by humidity
- Fire resistant
- Odorless

AMERICAN

AMERICAN OIL COMPANY
910 South Michigan Avenue
Chicago 80, Illinois

CHECK INDIVIDUAL *and* COMPOSITE ERRORS

in just ONE OPERATION



Fussy gear specifications studded with hostile tolerances need no longer foul up your inspection program

now, all readings flash on simultaneously

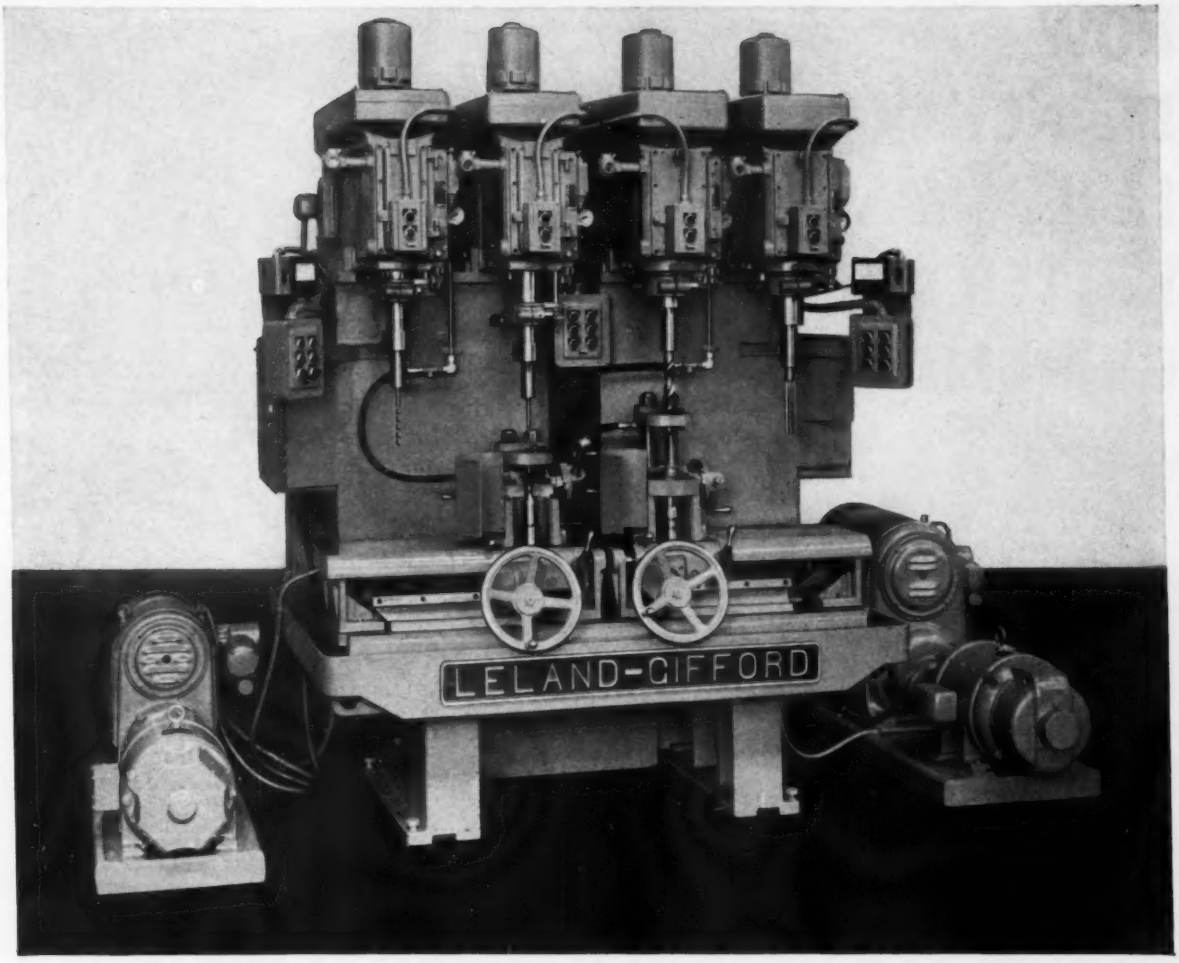
The New Red Ring Inertia Gear Analyzer speeds inspection 80% to 90% over conventional methods— and with laboratory precision

UP TO 500 GEARS PER HOUR

SPUR AND HELICAL GEAR SPECIALISTS
ORIGINATORS OF ROTARY SHAVING, GEAR HONING AND ELLIPTOID

NATIONAL BROACH & MACHINE COMPANY

5600 ST. JEAN • DETROIT 13, MICHIGAN



Designed for maximum utilization —

It goes without saying that Leland-Gifford special drilling machines deliver the production you want to the precision standards you set. But Leland-Gifford also has in mind the importance of design for maximum utilization to make your purchase of a Leland-Gifford machine a gilt-edge, quick return investment.

For Automatic Drilling at its best . . . be sure to see Leland-Gifford

THE JOB: Drill and ream a complete line of screw machine master collets and feed fingers ranging from $\frac{1}{8}$" to $1\frac{1}{4}$" diameter.

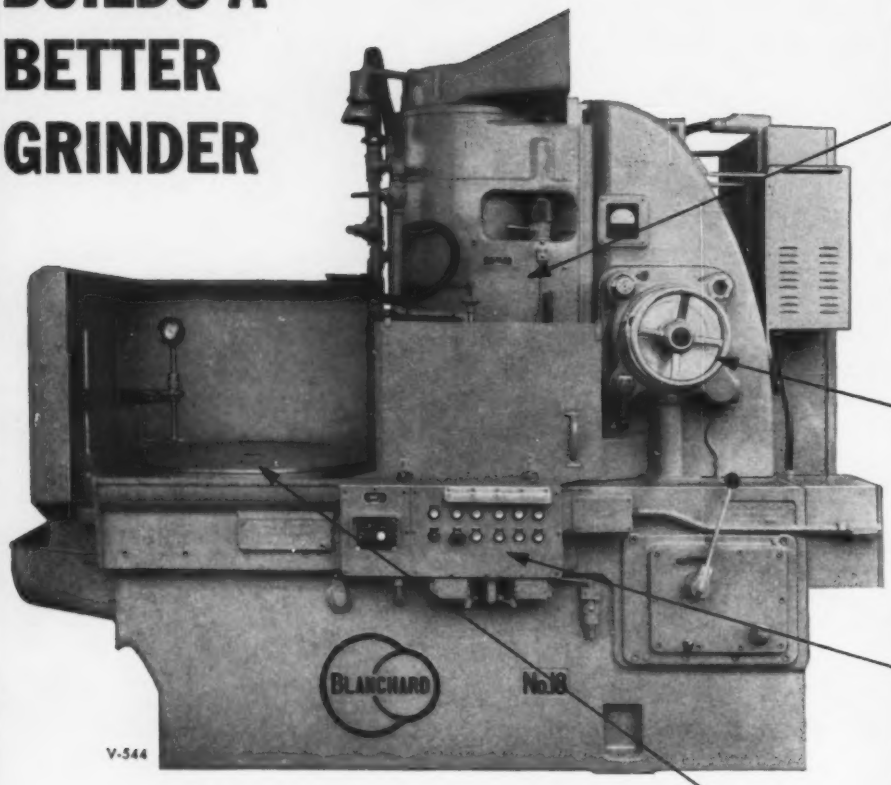
THE MACHINE: A dual operating Leland-Gifford special with two work-holding fixtures and four standard self-contained drilling units equipped for either plain or step feed. Workpieces are drilled in one location, indexed to second location and reamed. Spindle speeds are precisely controlled through variable frequency input to ac spindle motors. Hydraulic feed is infinitely adjustable with separate motors driving hydraulic pumps at constant speed regardless of spindle speed.

Write for complete information — or ask to have an experienced sales engineer call.

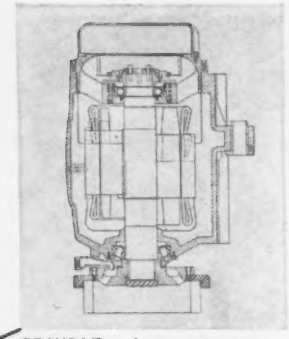
LELAND-GIFFORD
WORCESTER 1, MASSACHUSETTS
DRILLING MACHINES

For more data, circle this page number on Readers' Service Card

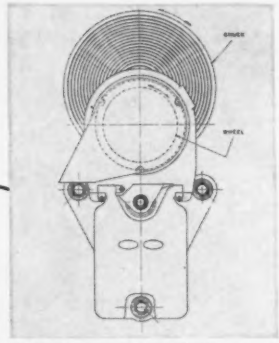
HOW BLANCHARD BUILDS A BETTER GRINDER



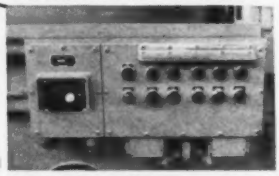
V-544



SPINDLE . . . incorporates a superior, pre-loaded anti-friction bearing system that removes all backlash and radial play. Integral "balanced" mounting of rotor on spindle eliminates vibration.

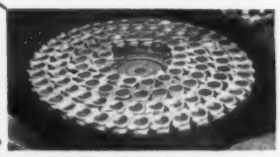


WHEEL HEAD COLUMN . . . is of heavy box-section design for extra rigidity . . . supported at 3 widely-spaced points. Column may be easily adjusted for alignment. Special column tilting devices available to produce concave or convex surfaces.



V-541

GRINDER CONTROL . . . is compact and conveniently located for fatigue-free handling. All control panels are BLANCHARD manufactured for troublefree operation.



W-949

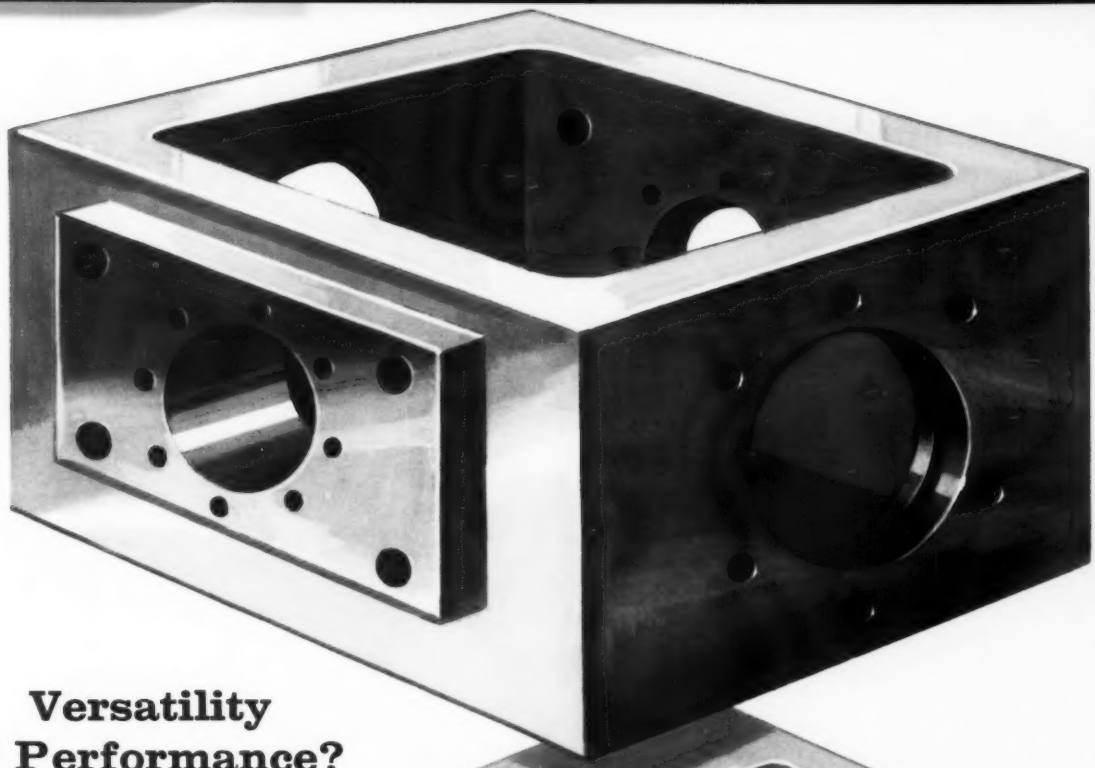
MAGNETIC CHUCK . . . provides maximum useful magnetic surface . . . has such closely spaced poles, that work as small as a quarter will always touch two or more.

There's no mystery about the *better* performance you get with a BLANCHARD Surface Grinder. It's simply a matter of *better* design of each individual machine part. For example, look at just 4 features of the No. 18, shown at the right.

Get complete details on all 24 models of BLANCHARD grinders. They're today's leading high precision, high production grinders on materials ranging from carbon to quartz . . . from bronze to steel. You can handle parts ranging from tiny jewels to giant plates up to 108″ across corners.

PUT IT ON THE BLANCHARD **THE BLANCHARD MACHINE COMPANY**
64 State Street, Cambridge 39, Massachusetts

For more data, circle this page number on Readers' Service Card



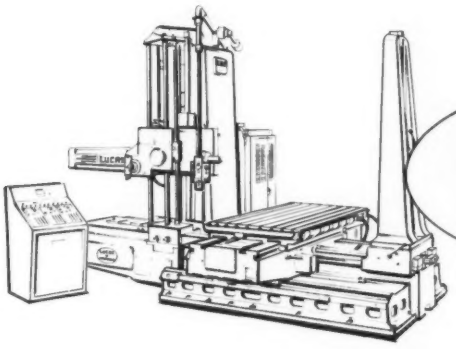
Versatility of Performance?

LUCAS

Lucas offers the widest range of machining operations possible on boring, drilling and milling equipment. The same versatility of application applies to work ranging from precision missile components to big castings and forgings weighing tons . . . on models ranging from 2¾″ to 7″ spindle diameter.

Point-to-point positioning. Milling (face milling, picture frame milling, right angle milling), boring (line and stub), drilling, tapping, threading, plus *contouring and profiling of complex surfaces.* Repetitive accuracy to ±.0001.

If your replacement or expansion plans include the addition of either vertical or horizontal table type or floor type boring, drilling and milling equipment, get the details on what Lucas has to offer. Lucas Machine Division, The New Britain Machine Company, 12302 Kirby Avenue, Cleveland, Ohio.



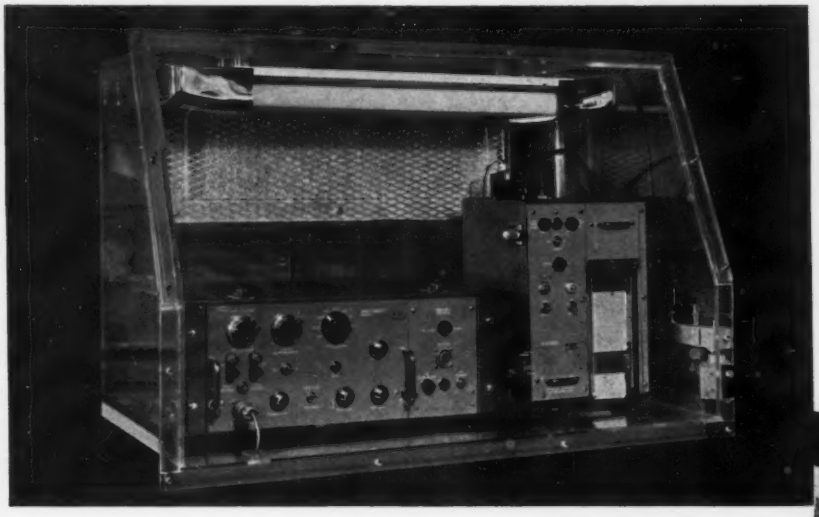
LUCAS
PRECISION

Saddle feed?

LUCAS

. . . plus precision flame-hardened column, table and saddle ways; a full range of speeds and feeds; maximum rigidity for precision machining accuracy on the heaviest cuts; air-lift to saddle and table during rapid traverse and every other major design and construction feature is available on Lucas boring, drilling and milling machines. These aren't the things we are going to incorporate someday, they are the accomplished cost-cutting features already at work in the field. Whether you require point-to-point positioning or contouring of complex surfaces, tape control or conventional pendant and/or lever control, Lucas represents the best value for your machine tool dollar. Before you decide on any other equipment for boring, drilling, milling and related operations, talk to your Lucas dealer or write Lucas Machine Division, The New Britain Machine Co., 12302 Kirby Ave., Cleveland, Ohio.

LUCAS
PRECISION



A Revolutionary New Way To Evaluate Grinding Wheel Hardness and Uniformity By Electronics

DYNA-GRADED®

Grinding Wheels by MACKLIN

Developed under the direction of the Macklin Research Department.

On May 10, at the Production Engineers' Conference at the A.S.M.E. at Toronto, a paper was presented on a method of scientifically determining grinding wheel hardness and uniformity. It involves using the Dynamometer, illustrated above, to *accurately determine wheel hardness and uniformity across the entire cutting face of the wheel under controlled rotating conditions which simulate actual grinding.*

Here's How it Works . . .

Minute amounts of abrasive are crushed from the wheel's cutting surface by a conical, hardened steel wheel which is in running contact with the grinding wheel being tested. The force required to crush these minute amounts of abrasive and bond is electronically recorded on a permanent tape. Any significant variation in wheel uniformity or hardness is recorded on the tape. *This means* Dyna-Graded® wheel characteristics are precisely predetermined *before* the wheel is shipped. This means we can assure you more accurate wheel duplication, order after order. This means better cost control of your grinding operations.

For more than a year, Macklin has been Dyna-Grading wheels. Within a few months, Dyna-Graded wheels will be available for most of your high production grinding operations. Why settle for less? Put Dyna-Graded Macklin wheels to work protecting your production. *For further information, contact your Macklin distributor or write us direct.*

Dept. 14

MACKLIN company Jackson, Michigan

®*The term Dyna-Graded is a registered trademark of the Macklin Company. Domestic and foreign patents applied for.*

Who else wants to save $100,000 this year?

How the Revere Technical Advisory Service Showed a Metal User the Way to Profit-Protecting Economies — and can do the same for you!

A leading manufacturer—you'd recognize the name immediately—is a heavy user of copper and its alloys. It buys sheet, strip, tube, rod—by the hundreds of tons. Recently, this company invited the Revere Technical Advisory Service to inspect its operations, study its metals needs, analyze its buying practices and look into its specifications. The Revere people were actually treated as members of the crew at the company's plants; nothing pertinent was kept secret, no knowledge hidden.

The result? Recommendations all down the line on every phase of copper and copper alloy procurement and use—and production savings made possible in every area. The Revere Technical Advisor actually showed the way to an astonishing potential saving . . . well over $100,000 yearly!

Naturally, not every company can expect such huge savings. Too many variables enter in. But *if* detailed knowledge of metals, their manufacture and their uses can be applied to *your* product and *your* production, the Revere Technical Advisors are at your service. These are the men who know non-ferrous metals best—and many other metals equally well. They are ready to serve you—*now*.

You can reach the Revere Technical Advisory Service simply by calling or writing the Revere Office nearest you. If you are interested in a cooperative program of this kind and in discussing your metals procedures fully—in confidence—call Revere today. You will find that you have taken the first step toward profit-protecting economies. No obligation, of course.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., New York 17, N. Y.

Mills: Rome, N.Y.; Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford and Plymouth, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities.

Distributors Everywhere

New

WESSONITE®

Cast Alloy Tools and Blanks

Wessonite bridges the gap between maximum speeds permissible with high speed steel and minimum speeds practical with carbides. Wessonite "H" is for general purpose machining of both ferrous and non-ferrous metals. Wessonite "HX" is for use where there is a minimum of shock or impact. Cutting speeds range from 100 to 190 sfpm for cast iron, from 50 to 300 sfpm for steels, and up to 1250 sfpm for aluminum.

To Make it Easier to Decide . . .

These Wesson booklets analyze all the factors involved in selecting the best type of tool for boring, for turning, for milling. Your Wesson field engineer has copies of all of them. Let us know which one you want.

WHICH IS BEST FOR TURNING... THROW-AWAYS,

How to get an

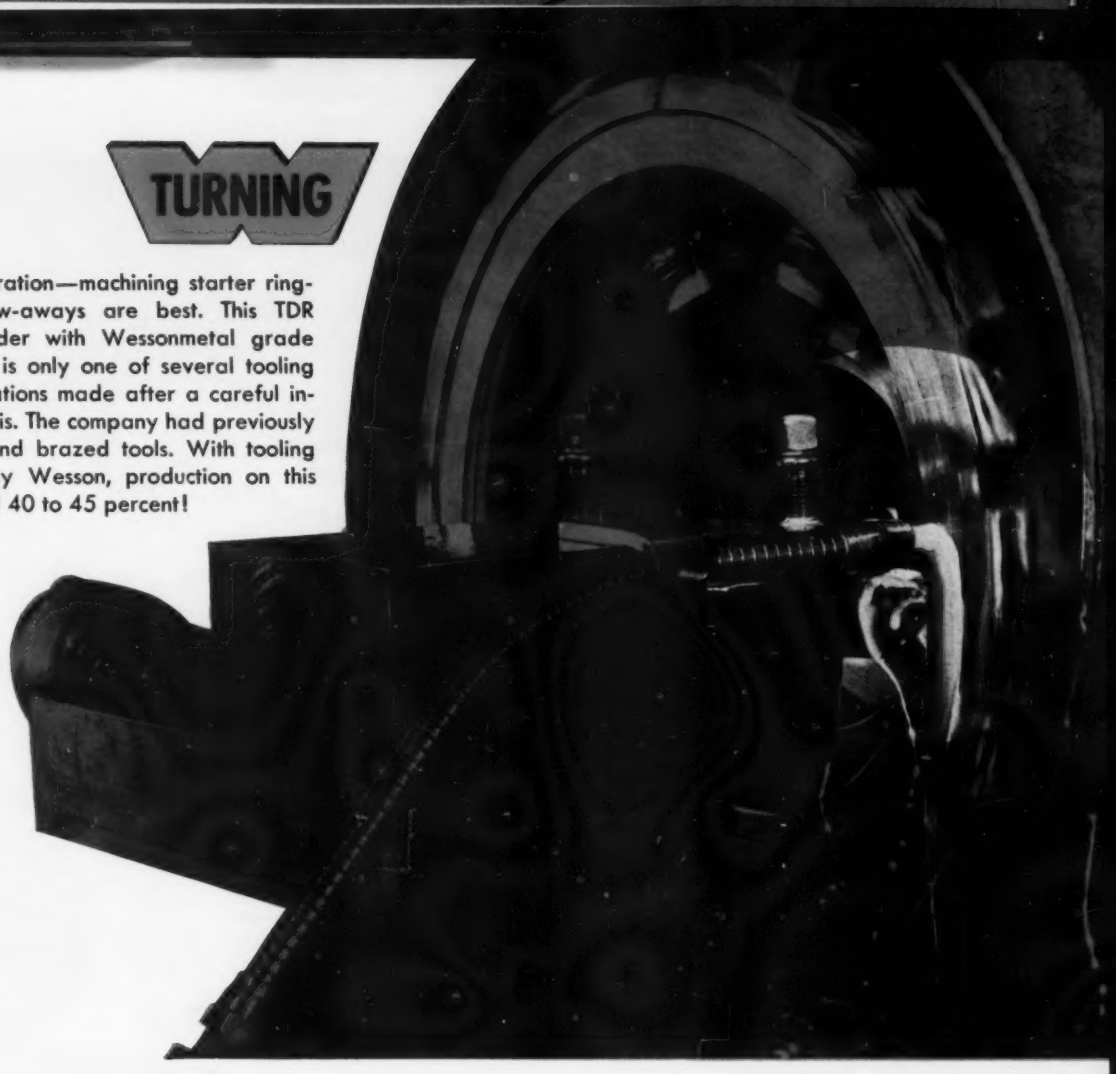
Ask Wesson . . . the answer will be unprejudiced because we make all *three* types. We can readily answer the question of which, where, when, why and how based on thousands of jobs successfully tooled with all three types of carbide tools.

Your local Wesson field engineer has immediate access to this accumulated experience plus his own extensive

WESSON

WESSON CORPORATION 1220 WOODWARD HEIGHTS BLVD., FERNDALE 20, MICH.

PLANTS IN: LEXINGTON, KENTUCKY • FERNDALE AND BRIGHTON, MICHIGAN



TURNING

On this operation—machining starter ring-gears—throw-aways are best. This TDR Multicut holder with Wessonmetal grade WM inserts is only one of several tooling recommendations made after a careful in-plant analysis. The company had previously used HSS and brazed tools. With tooling proposed by Wesson, production on this part jumped 40 to 45 percent!

ON-END or BRAZED ?

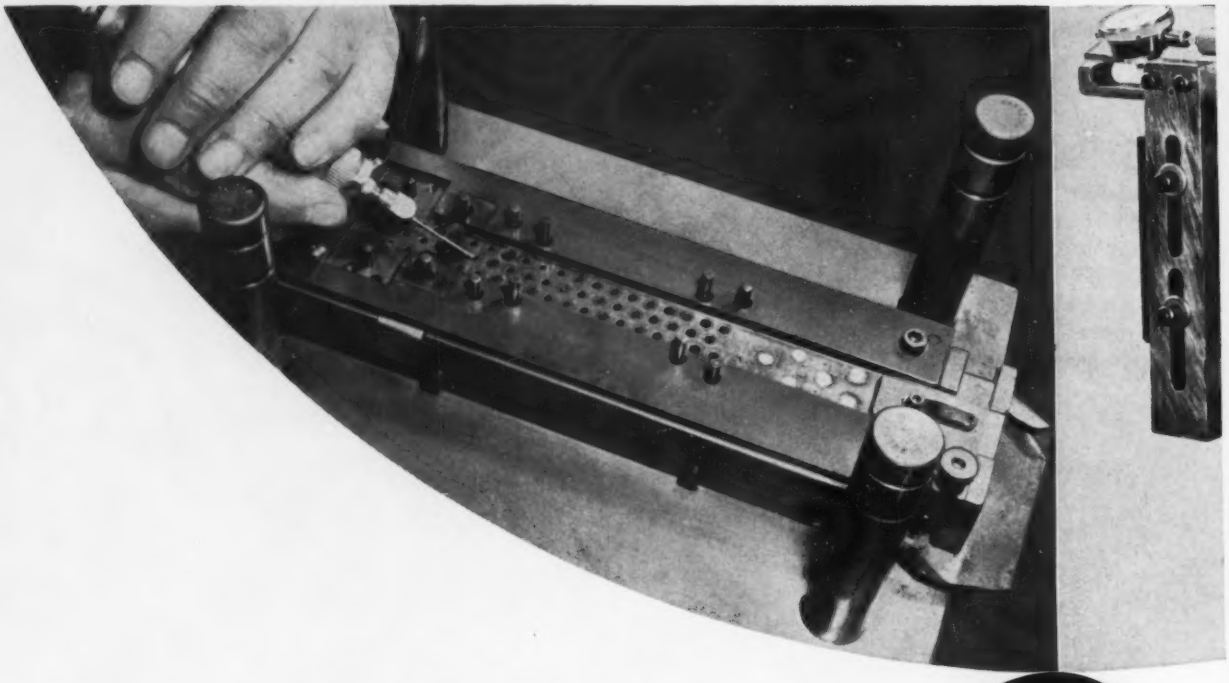
unbiased answer

training and experience in the carbide cutting tool field. He will be glad to make a complete in-plant study of your operations (no obligation of course) and recommend the best and most economical tooling.

Give him a call now . . . ask him about "guaranteed performance" and how you can get results like those shown here.

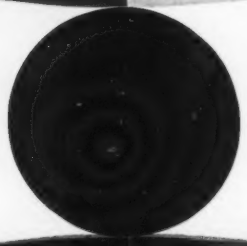
TURNING

On the same part, throw-aways also work best for gang-turning the OD of 21 gears at one time. The square inserts can be indexed eight times, give a total of 800 pcs. per insert. Results like this are what contributed to an over-all 40% production increase.

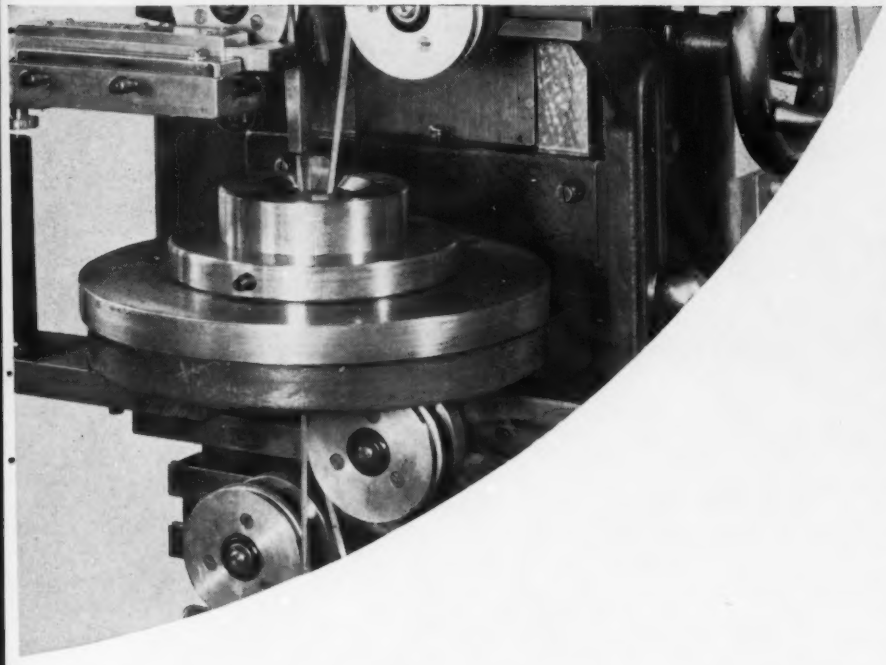


Grinding Ceramic Wafers *(below) for nuvistor tubes. Two diamond wheels finish 2000 wafers per hour for Electron Tube Division of RCA. Wheels remove 0.003" stock from each surface simultaneously. Previous method using abrasive belts ground only one surface at a time, resulting in nonuniform results and stoppages. Expected life of wheels: 5,000,000 wafers.* ▼

Servicing High-Speed Carbide Dies *(above). Jacoby Bender Inc. makes expansion watch bands. Their dies are for precious and semiprecious metals, as well as stainless steel. Finished products must have flawless finish. Small diamond quills from size .020" to ¼" diameter are used to build and service carbide dies. Grinders also cut decorative relief in some dies.* ▲



Industrial diamonds cut practically everything . . . especially your production costs



Polishing Drawing Dies *(above) for Chase Brass & Copper. Die-polishing job that once required 2 to 6 hours' handwork is now finished in 15 minutes with diamond belt polisher. Accuracies and surface finishes are also greatly improved. Belts are impregnated with 100, 200 or 300 mesh natural diamond grit. Up to 200 dies have been serviced by a single belt.*

Putting Mirror Finish *(below) on hardened steel part for a forming die at Jacoby Bender. The natural diamond micron powder is applied with a wooden lap. The diamond paste speeds up the polishing operation, and has less tendency to distort the true form of the tool-steel than methods previously used.*

Considering how well natural diamonds do these jobs may give you ideas

The four grinding and polishing jobs shown here span the fields of electronics, jewelry making, and metalworking. But they have one thing in common: in every case, natural industrial diamonds are doing the job quickly, economically and well.

In diamonds, you find this unique combination of properties: excellent cutting ability coupled with fantastic endurance.

Result: your diamond tools last longer than any other tools you can use. Your people spend more time producing, less time changing tools.

If you cut, sharpen or smooth in your business, you quite probably can use natural diamonds to advantage. Test them against the method you're now using. You will see how efficient — and economical—a diamond can be, especially now.

Best grit for metal-bond wheels developed by the Diamond Research Laboratory in Johannesburg

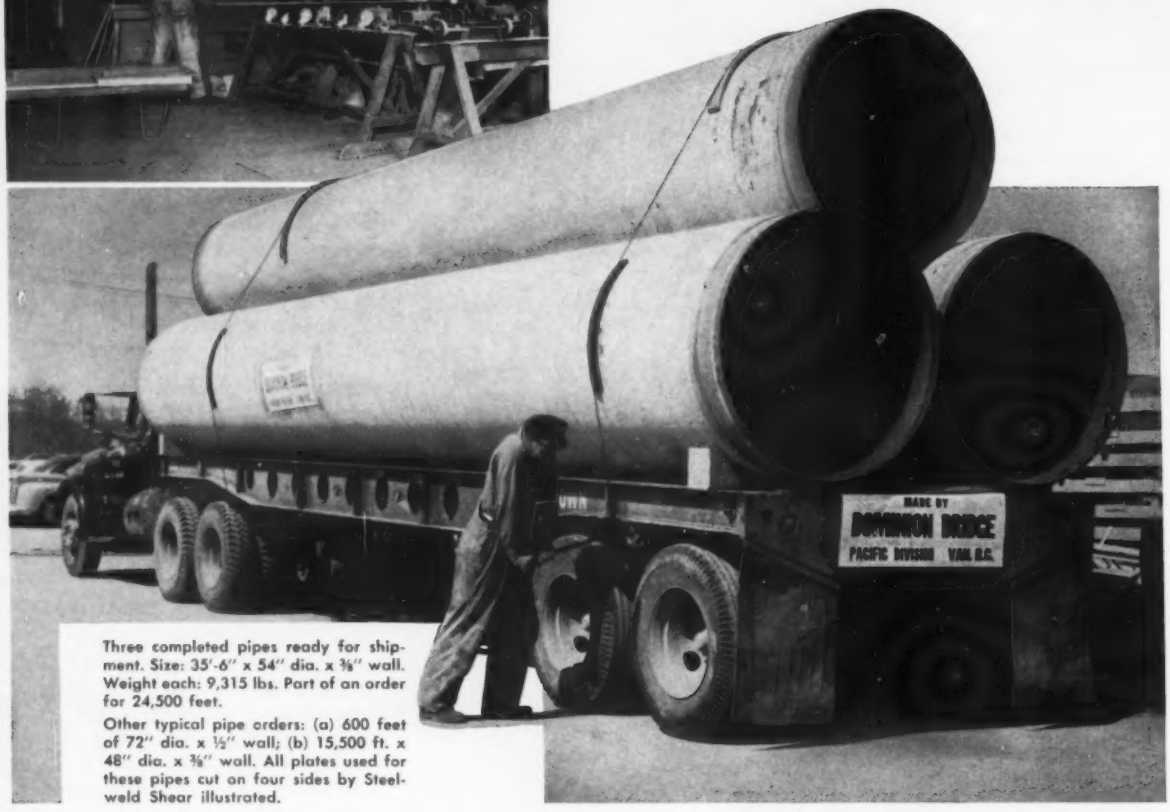
A new impact crushing method for natural diamonds is now producing the strongest and most durable diamond grit ever obtained for metal-bond wheels. Your tool and wheel manufacturer is ready to help you select the diamond tool that's right for *your* job.

Industrial Distributors (Sales), Ltd.

CUTS MILLIONS OF FEET OF STEEL SQUARE and ACCURATE

Steelweld Shear Speeds Big Pipe Line Shearing

This shear cuts pipe line plate accurately. It has been doing so for years with only minimum maintenance.



Three completed pipes ready for shipment. Size: 35'-6" x 54" dia. x ⅜" wall. Weight each: 9,315 lbs. Part of an order for 24,500 feet.

Other typical pipe orders: (a) 600 feet of 72" dia. x ½" wall; (b) 15,500 ft. x 48" dia. x ⅜" wall. All plates used for these pipes cut on four sides by Steelweld Shear illustrated.

Dominion Bridge Company, Ltd., is the largest steel fabricating concern in Canada. Among its many activities is that of making steel pipe for Canadian pipe lines. At its Pacific Division, Vancouver, B. C., pipe is made in various diameters, mostly 3'-0" to 5'-0", and usually in lengths of 35'-0" to 40'-0". Pipe walls generally range from ¼" to ½".

One typical order called for 35 miles of 36" pipe in 40'-0" lengths with ¼" and 5/16" walls. This required 10,000 tons of steel. Five to seven plates were used for each pipe. Each plate was cut on all four sides to assure accuracy and squareness required for perfect fitting. Over a million feet of steel was sheared for this job — all on one Steelweld Shear.

The machine worked 15 hours a day, cutting 12,000 to 14,000 feet. The knives needed turning to a sharp corner every 2 to 2½ months, which meant that only after 8 to 10 months of continuous production shearing was regrinding necessary.

Heavy construction of the shear, Steelweld's own air-operated clutch, easy knife adjustment to suit metal thickness, and electric foot switch control, are some of the factors contributing to the success of Steelwelds on hard service jobs.

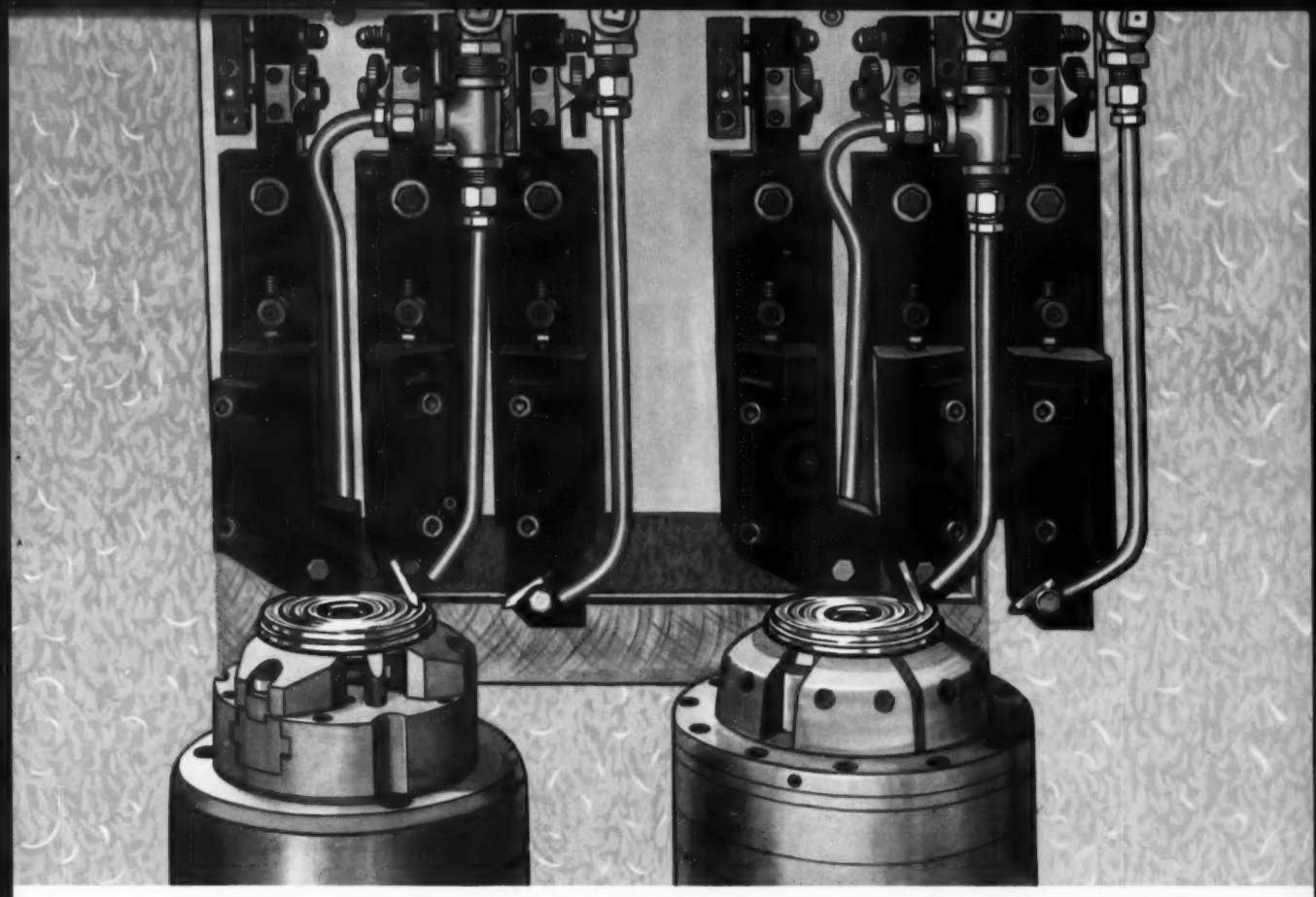
Write for Catalog No. 2011

STEELWELD

PIVOTED BLADE *Mechanical and Hydraulic* **SHEARS**

Steelweld Machinery includes: Mechanical & Hydraulic Shears and Press Brakes One-, Two- and Four-Point Straight-Side Presses, Speed-Draw Presses.

STEELWELD MACHINERY DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 5463 E. 282 ST. • WICKLIFFE, OHIO



New Britain's new concept for contour turning and boring

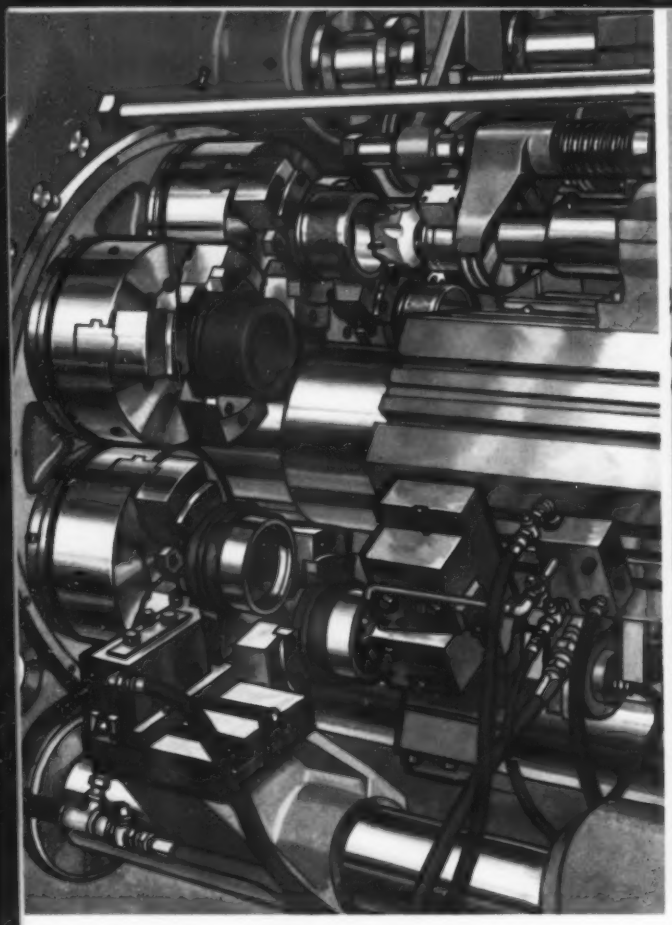
Beyond a certain point, continued refinement of existing designs in machine tools ceases to make an appreciable contribution to performance. Thus in designing our New Series of Vertical Precision Boring Machines, we have incorporated several completely new design concepts to provide improved performance and greatly increase over-all usefulness.

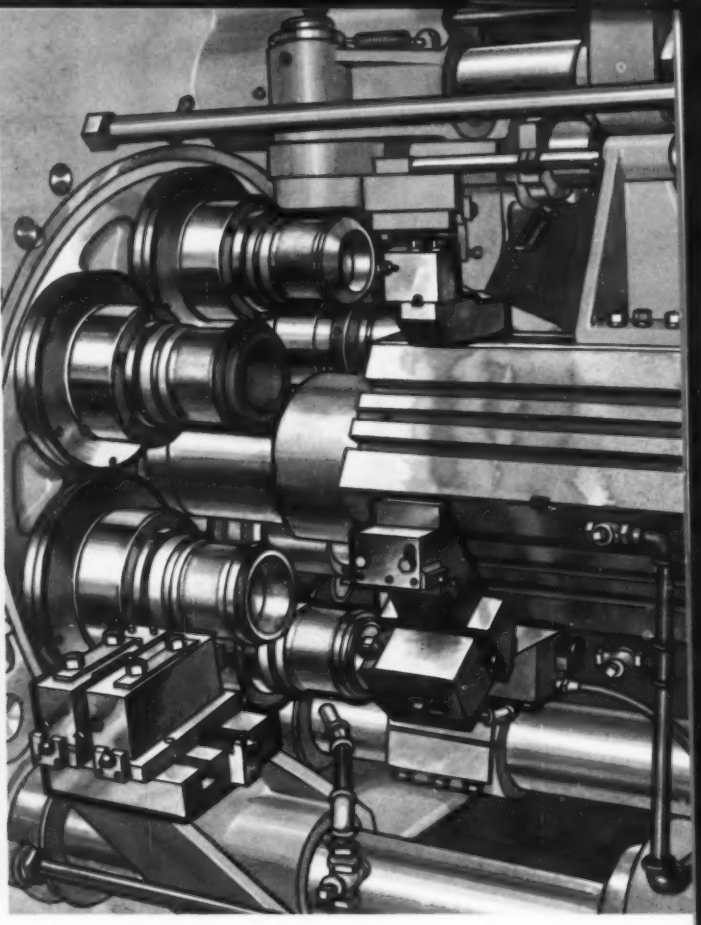
For the first time machines of this type can be used as building block units. Their clean-sided design permits any number of self-contained machines, each with one or more spindles, to be arranged side by side and operated as a single unit. They also may be operated with equal efficiency as individual machines. Parts can be inverted on adjacent machines or on adjacent spindles of the same machine.

In order to take the fullest advantage of the precision inherent in cam control, long linkages between cams and slides have been eliminated. A pair of cams is mounted on a common shaft which is carried *within the vertical slide*. Since all slide actuating forces are contained in the vertical slide, both cams are directly adjacent to the slides they control and no outside forces are imposed on the slide ways. The result is maximum rigidity for heavy cuts coupled with extreme accuracy for close tolerance work.

This unique and eminently workable approach to contour turning and boring results in the highest order of accuracy on even the most complex pieces. Your New Britain Representative can give you details on the nine different models available in this series. For catalog material, write The New Britain Machine Company, New Britain-Gridley Machine Division, New Britain, Conn.

THE NEW BRITAIN MACHINE COMPANY
New Britain-Gridley Machine Division - New Britain, Connecticut





New Britain . . .
still the best Chucker you can buy

We're not unhappy about the fact that for years, in many plants, the name New Britain has been synonymous with chuckers. New Britain Chuckers have turned out literally millions of pieces of work for practically every major industry in the world. This is less important to the prospective buyer of one of these machines, however, than the capabilities of these machines today. How do they stack up against other chuckers or even other types of machines capable of doing similar work? Pretty well, we think.

New Britain's open-end design still can't be beat for unlimited accessibility to the tooling area. This same wide-open feature makes it doubly more practical to adapt these machines to automatic loading and unloading.

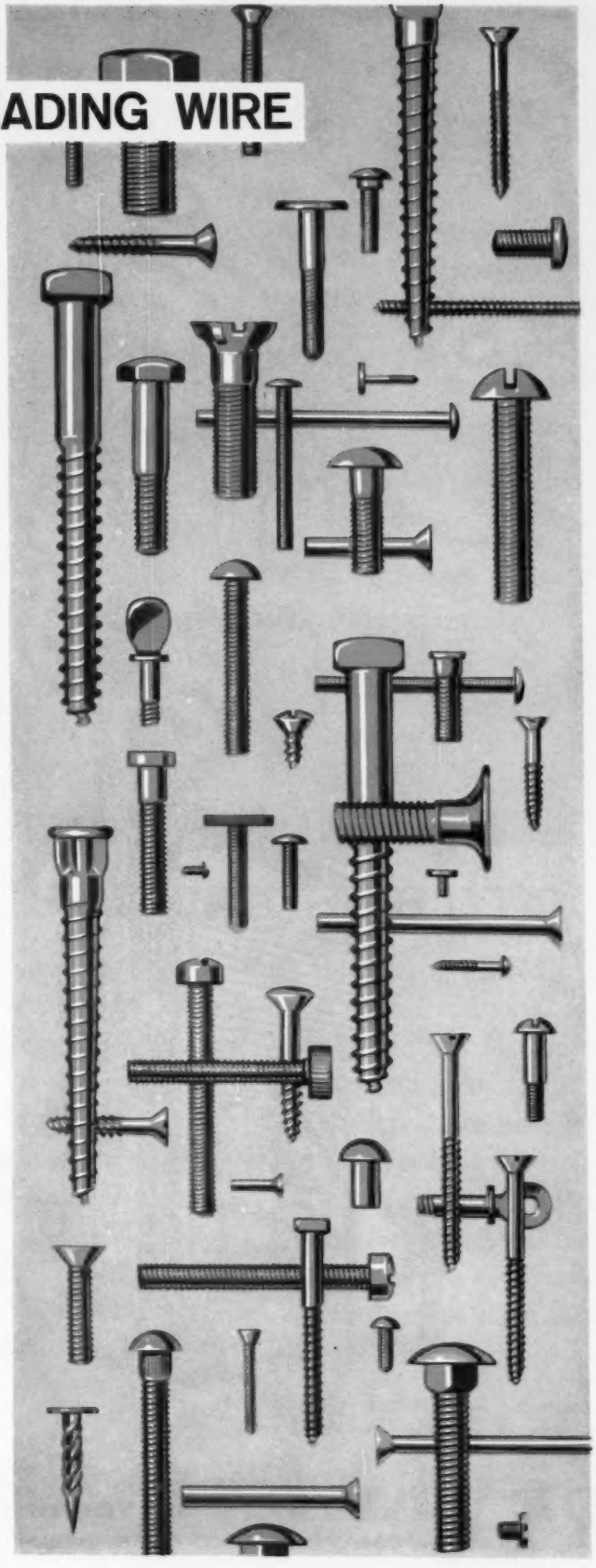
The unusual combination of longitudinal and transverse forming motions is another unbeatable New Britain feature. The massive forming arms on New Britain Chuckers allow heavier cuts and cuts of much greater complexity. This ability to do more work can eliminate the need for second operation machines in many instances. For really complex work, two chuckers set up side by side, as shown here, each doing one side of the piece, can smooth the way for high production. Less complicated work can be set up to perform both sides of the same piece on a single machine.

These massive machines provide the tooling combinations, spindle speeds and power to perform the widest possible variety of work. Their basic design will stay new for years to come, continuing to provide profitable operation. You may know New Britain Chuckers, but you may not be fully aware of the improved series presently being offered. Why not call your New Britain Representative or contact us at The New Britain Machine Company, New Britain-Gridley Machine Division, New Britain, Connecticut.

THE NEW BRITAIN MACHINE COMPANY
New Britain-Gridley Machine Division - New Britain, Connecticut

ANACONDA COLD-HEADING WIRE

take a new look at the way you're making these parts...



Cold-heading and upsetting operations require specific qualities in wire to obtain the optimum in quality and the most favorable unit cost.

Anaconda Cold-Heading Wire has those qualities . . . a greater range of alloys . . . a wider range of finer characteristics to satisfy almost any requirement for a cold-headed part. These include corrosion resistance, toughness, tensile and fatigue strengths, electrical conductivity, and good color matching with other metals.

And to further improve the qualities of Anaconda Cold-Heading Wire, new fabricating methods have been developed to produce wire with a superfine-grain structure and greatly improved physical and mechanical properties. Today these new manufacturing methods can be applied to both brass and phosphor bronze wire.

Certainly it will pay you to take a new look at the way you are making these parts. Among the many alloys available in cold-heading wire form, Anaconda alone has Formbrite®, Duraflex®, and Everdur®.

Publication B-33 gives complete details. Write for your copy—or call on our Metallurgical Department to help you with your problems. Anaconda has specialists in this field to help you at any time. See your Anaconda representative, or write: Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

61-1149

COPPER AND COPPER ALLOY COLD-HEADING WIRE

products of

ANACONDA®

AMERICAN BRASS COMPANY

For more data, circle this page number on Readers' Service Card

A single IMO pump can deliver up to
3000 gpm at 300 psi
1000 gpm at 500 psi
400 gpm at 3000 psi

For

wide capacity range...

DE LAVAL

IMO®

power-hydraulic

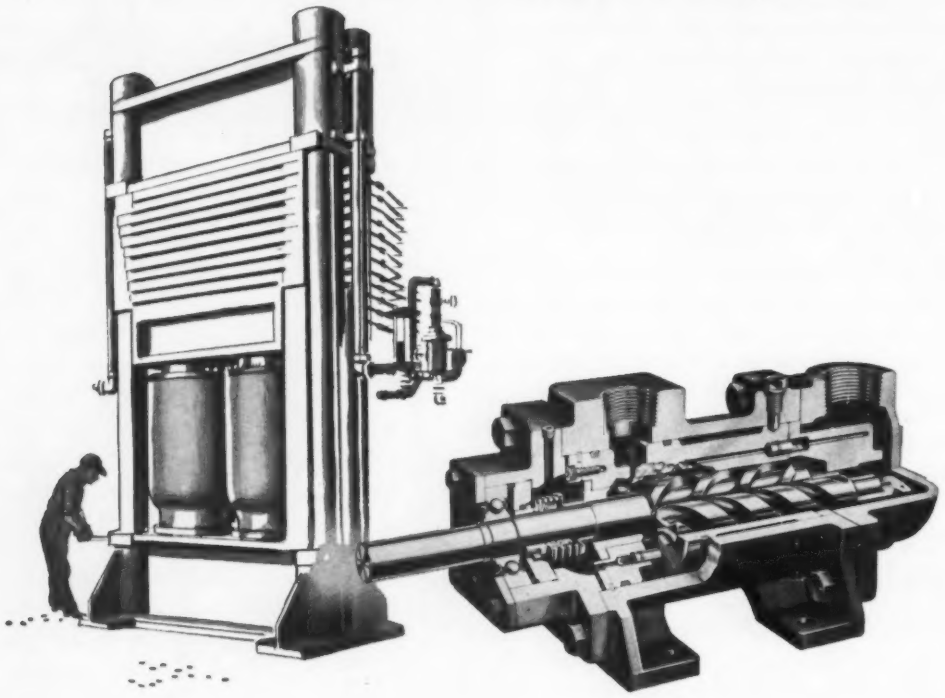
pumps

The wide range of volume and pressure capabilities of IMO pumps finds extensive use in hydraulic-press applications. These, as a rule, require high capacities at low to medium pressures for pre-fill service, then low capacity at high pressure during the working part of the stroke.

Versatile IMO pumps deliver maximum performance in many varied power-hydraulic applications. Besides wide capacity range, IMO pumps offer non-pulsating flow, quiet operation, high speed and reliability . . . even with fire-resistant fluids. Compact design saves expensive floor space. Installed cost is lower than for other types of pumps. IMO pumps cut maintenance, too . . . only three moving parts!

For application and performance data, selection information, dimension drawings and tables, write for Bulletin IM-3200.

De Laval Steam Turbine Company, Trenton 2, New Jersey.



IM-DL-106

DE LAVAL · 60 YEARS OF CREATIVITY AND QUALITY

CENTRIFUGAL PUMPS AND COMPRESSORS • TURBINES • IMO® ROTARY PUMPS AND HYDRAULIC MOTORS
MARINE PROPULSION AND AUXILIARY EQUIPMENT • HELICAL AND EPICYCLIC GEARS • TURBOCHARGERS

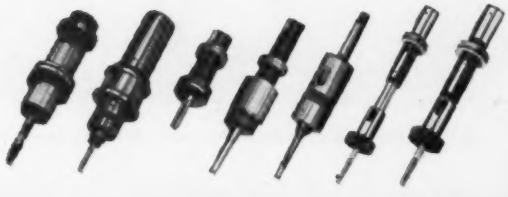
WHAT YOU CAN'T SEE CAN HURT YOU!

Most people can see and measure cutting tool wear (and prices). Many are watching frantically. But these are not the costs that hurt you. Cost of changing and setting tools in a machine easily can add up to eight times the cost of tool depreciation. These are hidden costs . . . but they are real. Do your shop people appreciate this? Tool budgets tell them to save tools. They do this by operating machines at uneconomical speeds. Profits go down the drain to make "paper clip" savings. Where is the emphasis in your plant? Tool life or least-cost production? Once people look through budgets to total tool replacement: (1) tool sharpening cost; (2) cost of tool change downtime; (3) tool resetting cost; and (4) tool depreciation, opportunities for cost reduction are obvious. Scully-Jones offers standard and special tooling to reduce TWO of these costs. In some cases, ALL FOUR. These tools can be applied to a variety of machines in your plant. They are designed to reduce hidden costs, which do not appear on a tool budget. They make higher machine speeds economical—reduce costs even with short tool life.

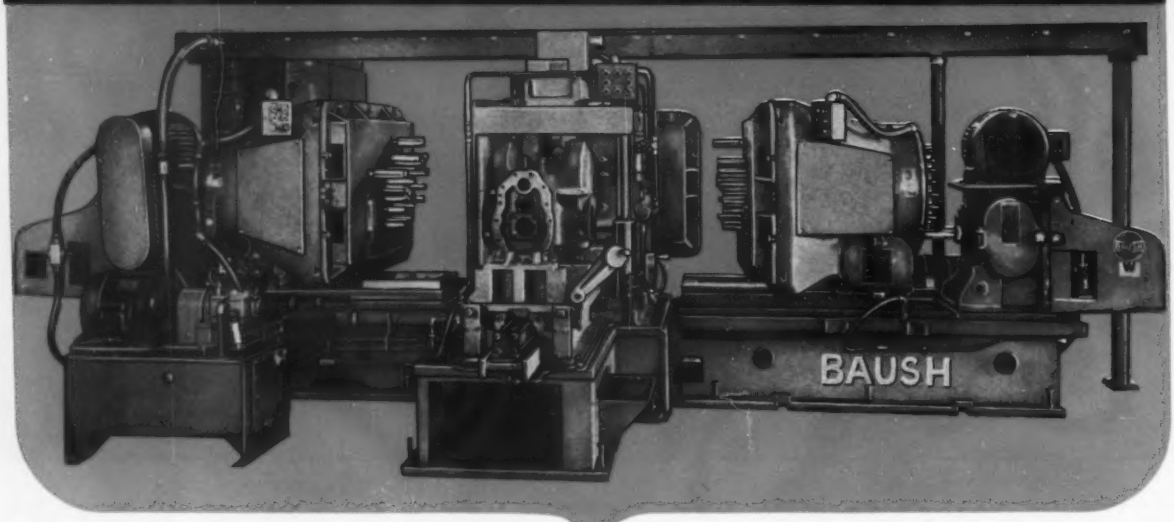
Scully-Jones and Company
1906 South Rockwell Street, Chicago 8, Illinois

SCULLY JONES

QUICK-CHANGE
QUICK-SET TOOLING



BAUSH 3-WAY "M" TYPE MECHANICAL MACHINE TAPS 78 HOLES IN SIDES and REAR OF TRANSMISSION HOUSING FOR TRACTORS



This multi-spindle tapping machine has 3 horizontal "M 25" machine sections mounted on a welded steel center base with 3—27"x50" rectangular heads.

Each head is bored and furnished with 38—2" diam. upper spindle pinions that have 2 speeds and a neutral position. The 3 master-bored cluster plates carry a total of 78 slip-sleeve spindles driven by three 25 HP, 1800 RPM motors.

A special holding fixture is designed to act as a carriage for the part and operates on hardened and ground ways. The part is set into fixture which is operated by a 5 HP, 1200 RPM motor, with three 1 HP, 900 RPM motors giving rapid traverse to the 3 heads.

Machine has Trabon lubrication throughout with Norgren lubrication for tapping. Electrical controls are to J.I.C. Standards and center base has chip conveyor.

In this installation the unit is used as a tapping machine only, on heavy tractor transmissions, but it can be readily adapted to drilling as well.

Why not let Baush Engineers build YOUR special machines — their experience of more than 60 years will pay you dividends in smooth, fast, competitive production.

B

BAUSH

MACHINE TOOL CO.

SPRINGFIELD 7, MASSACHUSETTS

Keeping up with Washington

Loring F. Overman

★ **Defense Department Studies Lead Time**

★ **DOD Tightens Rules on Advertising Costs**

★ **Small Business to Share Defense Contracts**

★ **Washington Briefs**

RETURN OF MILITARY THINKING to the level of conventional weapons is causing planners to consider new production equipment in terms of multiple millions of dollars. No one around the Bureau of Defense and Services Administration is willing to be quoted on the total sums of money under consideration, but indications are that there is sufficient money in the defense budget to swing the deal whenever someone gives a go-ahead on the type and scope of the conventional weapons program and the machine tools required.

Also reported around BDSA is the fact that the Department of Defense is taking second looks at conventional weapons plants and equipment which had been earmarked as surplus under the warfare-with-missiles policy. The Defense Department is operating under a sort of three-way plan insofar as production equipment is concerned. It is continuing to discard obsolete machines; is putting a "hold" sign on items which might come in handy; and is taking a "bolder and more imaginative approach" to the development of new weapons.

As explained by Army Secretary Elvis J. Stahr, Jr., "although we have developed some magnificent equipment, it seems to me that we must increase our capacity by an even more imaginative approach to the development of new fighting tools." The Secretary indicated that it is not enough to have new weapons. Instead, he said, they must be modern, preferably embodying revolutionary concepts strange to an enemy. Such a conclusion, in turn, involves modern thinking in the design and production of suitable machine tools.

Defense Department Studies Lead Time

Providing industry with a complete understanding of all factors involved in national security—not merely those affecting a particular company—is suggested by Defense Department officials as a means of reducing lead time between weapons ideas and weapons deliveries. One factor which is expected to encourage a better understanding of the problem is the new Defense Supply Agency, which was set up to take over the management of hundreds of thousands of common-use items needed by the Army, Navy, Air Force, and Marines. The new agency will be assisted by a Supply Council headed by Deputy Secretary of Defense Roswell Gilpatric. It is expected that the council and the supply agency will speed deliveries and reduce costs by (1) reduction of competition among the Services for resources; (2) encouraging equality of treatment among the Services; (3) freeing the individual Services to place more emphasis on their combat support missions; and (4) providing greater flexibility and simplicity in planning, programming, budgeting, and funding.

DOD Tightens Rules on Advertising Costs

Machinery manufacturers who have been including advertising costs as expense items on defense contracts are reminded that such charges are no longer allowable. The new rules were insisted upon by Congress in passing the Defense Department's appropriations bill. Conditions under which advertising charges will be allowed are included in Section 15-205.1 of Section XV of the Armed Services Procurement Regulations. In part, the regulation provides: "The only advertising costs allowable are those which are solely for the recruitment of personnel required for the performance by the contractor of obligations arising under the contract, when considered in conjunction with all other recruitment costs."

Small Business to Share Defense Contracts

Machinery-manufacturing companies which consider themselves as small business may find some encouragement in Army Circular 20-6. Its purpose is to direct purchasing agents and inspectors to determine whether:

(1) Sole-source procurements were eliminated insofar as possible;

(2) Greater opportunities were sought for procurement set-asides for small business;

(3) High priority, where applicable, was given to finding new methods of breaking out components of major weapons systems;

(4) Major prime contractors were encouraged to make greater efforts to eliminate sole-source subcontracting and increase competitive opportunities in subcontracting.

Washington Briefs

Defense spending on the basis of current programs will rise to $50,000,000,000 in fiscal 1963, probably without any tax increase, according to Charles J. Hitch, Assistant Secretary of Defense (logistics).

Army has issued a Research and Development Problems Guide, listing more than 1000 problem areas in which the Army is seeking assistance from private industry and from nonprofit organizations.

Capital expenditures, down to an annual rate of $33,500,000,000 in the second quarter, were expected to rise to a $34,800,000,000 annual rate in the third quarter, and to a $35,900,000,000 rate in the closing quarter.

An Advisory Council for small business has been appointed by John E. Horne, Administrator of the Small Business Administration. Purpose of the council is to advise with the SBA in an effort to improve the role of small business in the defense program.

HARDINGE
ELMIRA, N.Y.

Electronic, Optical,
Computer, Gauge and
Instrument Manufacturers find
HARDINGE Machines essential
in the production of the
Super-Precision required.

HARDINGE BROTHERS, INC., ELMIRA, N. Y.
"PERFORMANCE HAS ESTABLISHED LEADERSHIP FOR HARDINGE"

OFFICES IN PRINCIPAL CITIES. Export Office—269 Lafayette St., New York 12, N. Y.

Machinery
NOVEMBER 1961

WHY???

THE Walsh-Healey Public Contracts Act passed by Congress in 1936, among other things, provides the Secretary of Labor with broad powers to determine and enforce minimum wages for all industries doing business with the Federal Government under contracts in excess of $10,000. Under this act, the Secretary of Labor is empowered by Congress to determine what the "prevailing" minimum wage is for specific industries. The minimum wage thus established becomes law. It is equal to or higher than the $1.15 minimum wage recently set by Congress under the Fair Labor Standards Act.

The Department of Labor is now in the process of applying a Walsh-Healey minimum wage to the machine tool industry. Hearings toward this end have been held and briefs of interested parties have been filed. If the requests of the AFL-CIO are heeded, the minimum wage for the machine tool industry will be set at $2.15 per hour, including an allowance for fringes, or around $1.00 more than the FLSA minimum wage.

At the present time the machine tool industry is suffering from a depression, operating at only between 50 and 60 per cent of capacity and having over 10 per cent fewer employes than a year ago. An unfair high minimum wage would inflict a hardship on many concerns of the industry. It might necessitate paying apprentice boys the minimum wage and, of course, re-establishing wage scales within each company. All this at a time when American machine tool prices are already necessarily high in comparison with imported machines.

It is the contention of the National Machine Tool Builders' Association that the Department of Labor has failed to consider relevant facts; that the department's 1960 survey contained many errors; that the survey is outdated; and that the term "covered employes" was so ambiguous as to lead to erroneous interpretations. Some companies were misled into overreporting by as much as 75 cents an hour. To establish a minimum wage on this survey would be manifestly unfair in the opinion of industry leaders. The NMTBA conducted its own survey, using what it considers the correct definition of "covered employes." Based on these data, a minimum wage would fall around $1.39 an hour.

The Department of Labor chose to institute this action at a time when the Office of Civil and Defense Mobilization, the Department of Commerce, and other government agencies were actively investigating the depressed conditions in the machine tool industry and seeking steps to alleviate this serious threat to national security. The Department of Labor was aware of the activities of its sister agencies, but nevertheless proceeded with its plans.

If the Secretary of Labor feels that it is necessary at this time to apply the Walsh-Healey Act to the machine tool industry, it is to be hoped that he will resurvey the industry or else use the NMTBA data.

Charles O. Herb

EDITOR

ACCURACY AND GRIP...

● Precisely the point...

When you buy new tools or rebuild old ones

START UP FRONT

- Precisely the point where the tool does its work.
- Precisely the point where profits are made and lost.
- Precisely the point where the accuracy and grip of Jacobs Chucks reduce tool breakage, downtime and rejects.

This is precisely the point, start up front with Jacobs.

The Albrecht Chuck is the world's finest heavy duty keyless drill chuck. It is ideal for use on high speed, sensitive drilling machines, for close tolerance work on milling machines or jig borers.

- All working parts ground and hardened
- Every piece interchangeable
- Hand locking, self tightening
- Minimum runout, exacting accuracy
- No springs . . . no key

INDUSTRIAL TEAMWORK

Your industrial supply distributor knows your business. He is always ready to fill your needs quickly and economically. When you need chucks you can depend on this industrial team—Jacobs and your Jacobs industrial supply distributor.

Jacobs **CHUCKS**

INDUSTRIAL DISTRIBUTORS SERVING INDUSTRY ECONOMICALLY THE RIGHT HAND OF PRODUCTION

THE JACOBS MANUFACTURING COMPANY,
WEST HARTFORD, CONNECTICUT

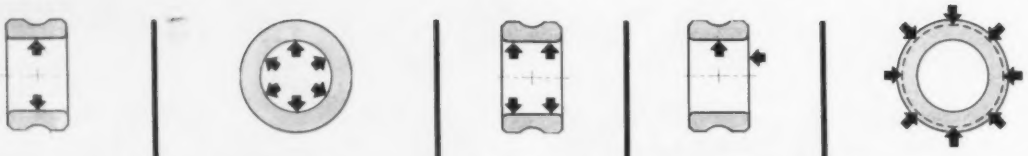
Machinery
Vol. 68 No. 3
November 1961

PRECISION BEARING TECHNOLOGY TAKES A GIANT STEP

Ball bearings for inertial guidance systems must meet greater accuracy demands than did the best bearings available only a short while ago. Thus evolved the "20-millionths" bearing. Here is the story describing manufacturing and inspection methods that permit such a high degree of precision to be consistently achieved in volume production

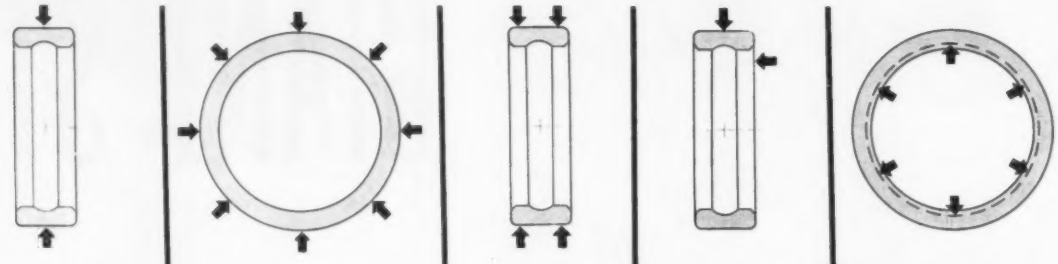
RAYMOND H. SPIOTTA
Managing Editor

INNER RING



	Bore Diameter	Bore Roundness	Bore Taper	Side Runout with Bore	Raceway Roundness
ABEC-7	+0.00000" −0.00015"	No Specification	No Specification	0.0001"	No Specification
20-Millionths	+0.00000" −0.00004"	0.00002"	0.00002"	0.00002"	0.00002"

OUTER RING



	Outside Diameter, Size	Outside Diameter, Roundness	Outside Diameter, Taper	Side Runout with Outside Diameter	Raceway Roundness
ABEC-7	+0.0000" −0.0002"	No Specification	No Specification	0.00015"	No Specification
20-Millionths	+0.00000" −0.00004"	0.00002"	0.00002"	0.00002"	0.00002"

Fig. 1. Size and geometry tolerances are compared, point by point, between 20-millionths bearing and those of ABEC-7

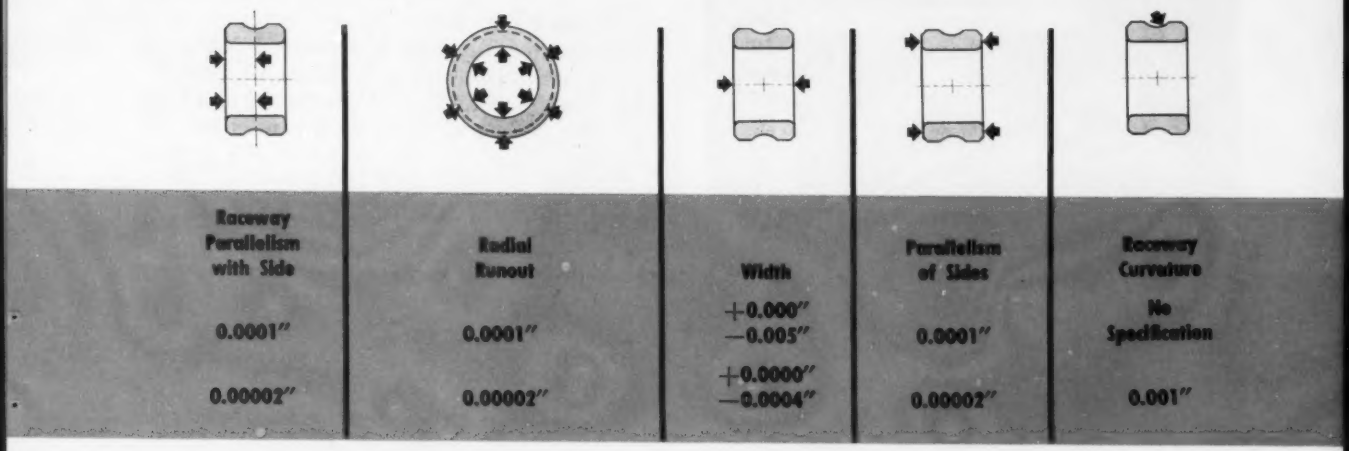
IT BECAME EVIDENT a few years ago that the navigational requirements established for the United States' intercontinental ballistic missile program far exceeded the capabilities of the precision bearings then available for inertial guidance systems. A tenfold advance in bearing accuracy was needed—more than had been accomplished in the previous twenty years of precision bearing development.

Such an advance has now been made and bearings having fourteen vital dimensions held within tolerances of 20 millionths of an inch are being manufactured in production lots by The Barden Corporation, Danbury, Conn.

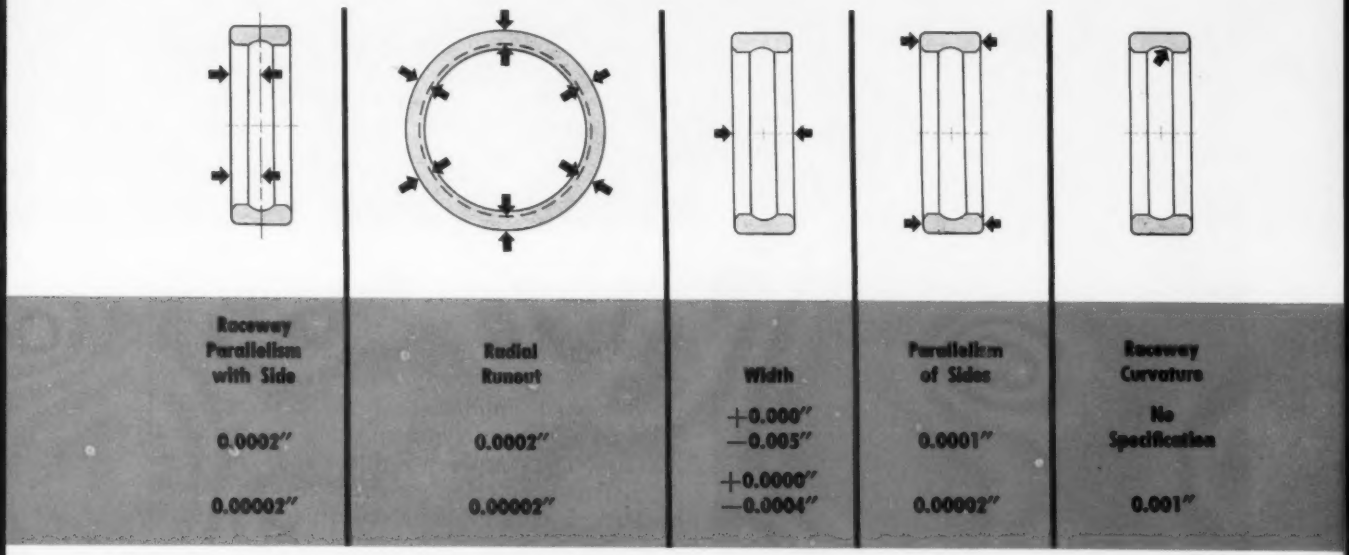
This step forward stems from a program initiated in 1956 by the Instrumentation Laboratory of the Massachusetts Institute of Technology under Air Force sponsorship, with Barden selected to proceed with development. Prototype bearings made to 20-millionths-inch tolerances were delivered less than two years after the start of the program. Basic new manufacturing and quality-control procedures for volume production were evolved shortly thereafter.

A Fresh Viewpoint

A company team of specialists in research, development, manufacturing, and quality control took a fresh approach to the problem. Instead of enlarging upon standard manufacturing processes and quality-control techniques, they sought radi-



Raceway Parallelism with Side	Radial Runout	Width	Parallelism of Sides	Raceway Curvature
0.0001"	0.0001"	+0.000" −0.005"	0.0001"	No Specification
0.00002"	0.00002"	+0.0000" −0.0004"	0.00002"	0.001"



Raceway Parallelism with Side	Radial Runout	Width	Parallelism of Sides	Raceway Curvature
0.0002"	0.0002"	+0.000" −0.005"	0.0001"	No Specification
0.00002"	0.00002"	+0.0000" −0.0004"	0.00002"	0.001"

requirements. In the more precise bearing, a 0.000020 inch tolerance must be maintained for fourteen dimensions.

cally new production and gaging methods. The search resulted in the design and development of a new group of special gages making use of motor drives and recorded read-outs.

On the manufacturing end, new methods of holding parts during critical grinding and lapping operations were developed and new stress relief procedures were introduced. There are more than 100 manufacturing and assembly operations and nearly as many inspection steps, involved in the production of but one 20-millionths bearing.

As can be surmised from the foregoing, the cost of these bearings is comparatively high. To be more specific, the tenfold improvement in accuracy over ABEC-7 tolerances was obtained at a cost increase per bearing of approximately 100 to 1. A point-by-point comparison of size and geometry tolerances held on ABEC-7 and 20-millionths bearings is displayed in Fig. 1.

Outer Rings Undergo Three Grinding Sequences

Accuracy of the order demanded is not achieved by following conventional operational sequences. For example, three separate grinding steps have been adopted—soft grinding, rough (hard) grinding, and finish grinding.

Going into detail on the outer ring, bars of vacuum-melted 52100 steel are roughed out and cut off on an Acme-Gridley six-spindle bar machine. The rings then go to a Blanchard for soft

radii at the corners. The rings are tumbled part to part, using only Brill soap and water.

Heat-treatment is done in a Leeds & Northrup shaker-hearth furnace, Fig. 2. Rings are brought up to a temperature of 1540 degrees F. and held there for a period of three to five minutes. Oil quenching follows at the opposite end of the furnace. The parts are also drawn for two hours at a temperature of 385 degrees F. Final result is

Fig. 2. (Above) Bearing rings are being fed into shaker-hearth furnace. Parts are time-cycled through furnace and quenched at the opposite end. This, with special draw in later operation, imparts required hardness and stability.

Fig. 3. (Below) For this finish face-lapping operation the bearing rings are placed in circular work-holders on lower cast-iron lap. Laps are flooded with compound and rotated to bring both ring faces parallel and flat within 0.000020 inch.

face grinding (the term soft grinding refers to those operations performed prior to the first heat-treatment). One face is ground at a time, with the cutoff side being the first to be done. About 0.002 inch of material is left across the width.

Soft grinding of the periphery is accomplished on a Cincinnati centerless machine. Although 0.008 inch is left on the diameter for subsequent operations, a tolerance of 0.0005 inch is held.

After stamping a serial number on one face of the outer rings, they are soft tumbled. This is to remove all machining marks and to form small

a minimum hardness of 59 Rockwell C in metal having less than 3 per cent retained austenite.

With the outer rings now hardened, "rough" grinding is performed. First, both faces are rough-lapped simultaneously in a throughfeed cycle on a Norton Hyprolap using bonded-abrasive laps. The periphery is then rough-ground on a Cincinnati centerless machine. This is followed by a rough bore grinding operation on a Heald centerless machine.

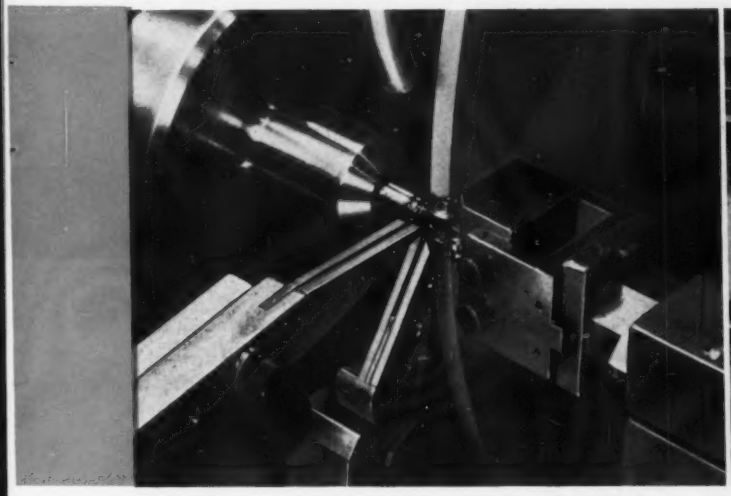
Roughing of the raceway is done on a Heald shoe type grinder. Here the word "rough" can be considered a proper term only in the sense that it applies to the first grinding operation on the raceway. Actually, tolerances in this operation are held from 0.0001 to 0.0002 inch, or what would normally be thought of as finish tolerances for ABEC-7 bearings.

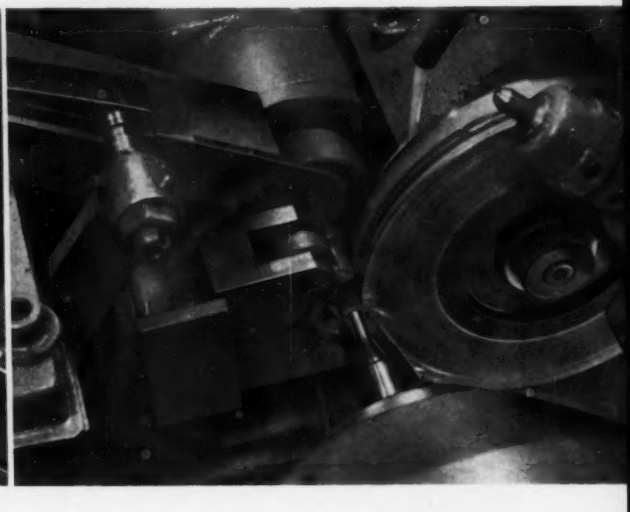
After every surface has been rough-ground, the rings receive a final stress relief. Temperature and holding time are critical at this point. In the interest of stability in the finished part, the rings are heated to a temperature of 355 degrees F. and held there for the lengthy period of 110 hours. Metal hardness of 59 to 61 Rockwell C is maintained.

A thorough washing follows stress relieving and precedes finish face lapping on a Norton 10-U machine, Fig. 3. Eighteen rings are nested

Fig. 4. Semifinish centerless grinding of outer surface of inner ring. Located from rough-ground raceway, the part is ground with squareness to face held within 0.000020 inch and roundness within 0.000075 inch. The finished land surface serves as reference for finish bore grinding.

Fig. 5. Centerless grinding inner-ring bore to semifinish size within a tolerance of 0.0002 inch. Roundness and taper are held here within 0.0001 inch, while squareness with face is held within 0.000020 inch. The ring is positioned by holding the land surface against three guide rolls.





in each of seven circular work-holders riding between two cast-iron laps. During this operation the parts are brought to a face-to-face parallelism of 0.000020 (20 millionths) inch and a width-measurement tolerance of 0.0004 inch. Incidental to the main object of this operation is a surface finish of 1 micro-inch that is obtained. A standard lapping compound is used, and the laps are run together between batches.

Starting off the third round of grinding operations, the periphery is finished on a Cincinnati Micro-Centric. This is a centerless setup using narrow carbide shoes. Squareness of the periphery to the face is the critical factor here, and this is kept within 0.000020 inch.

To assure accuracy at this point several special procedures are followed. For example, the back-up, or driving, plate is always reground while still on the machine. Also, both carbide shoes are ground in the toolroom, but are lapped after being set up on the machine.

Inspection is next, but first the parts are thoroughly washed. Washing also follows inspection, at which time the rings are coated with a rust preventive. This is a protective measure in the event the rings are temporarily stored at this stage before returning to the production line.

Finish grinding of the raceway makes use of the same tooling used during rough grinding. Eccentricity of the raceway to the periphery is maintained within 0.000030 (30 millionths) inch. Groove wobble with respect to the face, as well as groove roundness, is held to the same figure.

To accomplish this a specially designed head of high accuracy is used on the grinder. In addition, the carbide shoes that locate the ring are unusually narrow. These smaller shoes do have one drawback, however—they result in a higher unit pressure against the surface of the work. A slight shoe mark is left, necessitating a finish-lapping step.

When the raceway has been finish-ground the outer rings are scrubbed clean and dried by tumbling. To complete the major manufacturing steps on the rings they are completely inspected, ultrasonically cleaned, then oiled. But this is not the end. A sequence of refining operations is performed prior to final inspection and assembly and will be described later.

Inner Rings Follow Same Steps of Precision Manufacture

As with the outer rings, inner rings get close attention from first to final operations. They start off simply on an automatic bar machine, followed by a secondary operation to chamfer the edge of the bore. Heat-treatment follows a soft radii

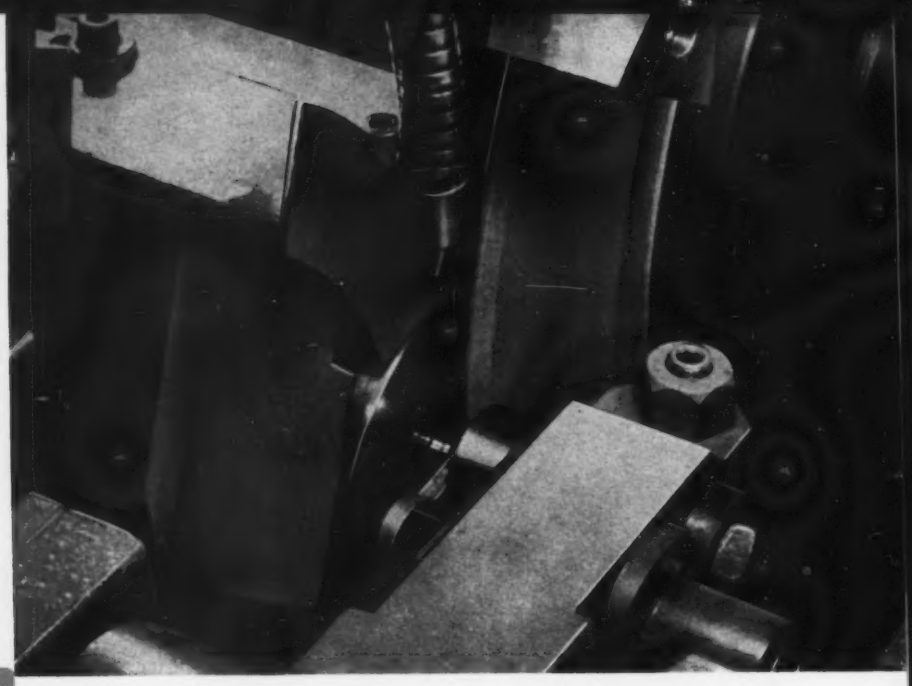


Fig. 6. During finish centerless grinding of the raceway, inner ring is held and driven by a magnetic chuck while guiding on ring bore. Tolerance is 0.000020 inch on roundness, wobble, and eccentricity.

tumble. Temperatures and sequence are the same as for the outer rings.

Inner rings, however, bypass the rough lapping accorded outer rings, jumping directly to finish lapping. Parallelism, face to face, is controlled to 0.000020 inch, while plus 0.0004 minus 0.0000 inch is held across the width.

Washing separates this step from the semi-finish grinding of the periphery, Fig. 4. As has been the case right along, this is a centerless operation and is being done on a Micro-Centric machine. The ring is supported from the front and from beneath by carbide shoes. The front shoe locates in the roughed raceway. A pair of ball-bearing rollers press against the right-hand face to hold the ring in contact with the driver.

Roundness of the periphery—actually the land surfaces—is held to 0.000075 (75 millionths) inch. Squareness of the lands with the face is within 0.000020 inch. Such a fine figure is demanded because the lands serve as locating surfaces during bore grinding.

In Fig. 5 can be seen the setup for bore-grinding the inner rings on a centerless, roll type Heald. The part is positioned by holding the land surfaces against three guide rolls—one large driving roll and two small idler rolls. Automatic magazine feed and ejection are a part of the machining cycle. Applicable tolerances here are 0.0002 inch on size and 0.0001 inch on taper and roundness. Squareness of the bore with the face is held to 0.000020 inch.

A final centerless grinding of the land periphery is done to remove any impregnation of the surfaces that may have occurred due to frequent contact with carbide shoes. A size tolerance of 0.0001 inch is maintained.

Rough lapping of the bore is next. In this operation a roundness of 0.000020 inch is achieved. Original squareness with the face of 0.000020 inch must not be disturbed, while taper is held to 0.000030 inch.

In a final "coarse" operation the raceway of the inner ring is finish-ground, Fig. 6, on an automatic Landis Concentric. The part is held and driven by a magnetic chuck and guided from within the lapped bore while the formed wheel shapes the groove. Three 0.000020-inch tolerances are met: groove wobble with respect to the face, groove eccentricity with the bore, and roundness.

Special Equipment Puts Finishing Touches on Rings

Final refinement of the inner and outer rings is done on special equipment at separate facilities of the Barden-RPM Division, which was created to perform such specialized bearing and subassembly functions. Most of the equipment here has been company designed to impart the last degree of accuracy to the bearing parts.

A typical unit is the bore-lapping machine illustrated in Fig. 7. Developed specifically for the 20-millionths bearing program, it finishes the bore diameter to a size tolerance of 0.000040 (40 millionths) inch while holding near-perfect round-

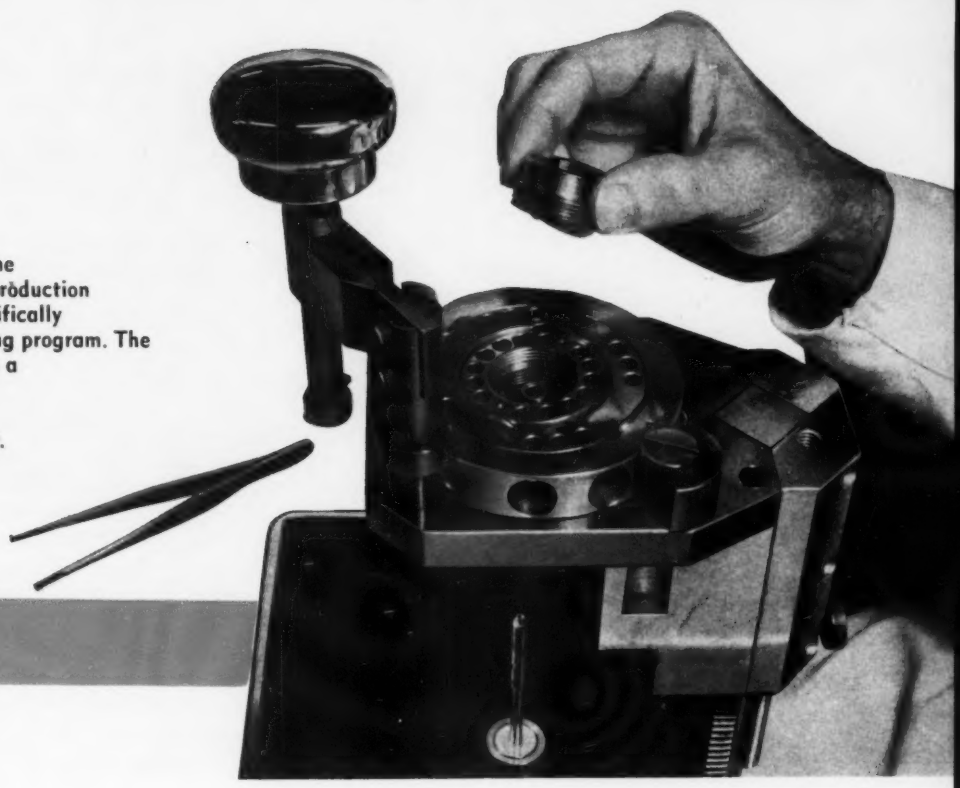


Fig. 7. Bore-lapping machine is one of several pieces of production equipment developed specifically for the 20-millionths bearing program. The lapping tool is mounted on a universal joint, while the inner ring is nested in a gimbaled work-holder.

ness, yet it does not disturb the bore squareness established by a previous grinding operation.

Key to the process is the manner in which the work is presented to the lap—both the lap and the inner ring are free to float, thus following the squareness already created. The lap, although a conventional tool, is mounted on a universal joint. A three-ring gimbal type work-holder supports the part. The center and inner gimbal rings are free to move as the operation progresses. These same two gimbal rings have been lightened by a series of bored holes to reduce the mass effect of movement.

The face-clamping nut being held by the operator secures the work-piece in place at the center of the inner gimbal ring. Fine LA-1 compound is used as an abrasive during the operation, being applied to the lap before starting each ring.

Progress is checked on the spot by a bore gage graduated in increments representing 10 millionths of an inch. In addition to size, roundness is also checked. Bellmouth is determined by checking at three places, the center and both ends. The bore-lapping operation can correct undesirable conditions of roundness and taper within 0.000020 to 0.000030 inch. Both before and after lapping, the parts are cleaned with varsol.

Initial lapping of the inner-ring raceway is carried out on the Barden-developed machine shown in Fig. 8. Although the device is small enough to sit on a table top, it dwarfs the work-piece gripped between the ends of the tweezers held in the operator's hand.

Abrading is accomplished by the roll of 4/0

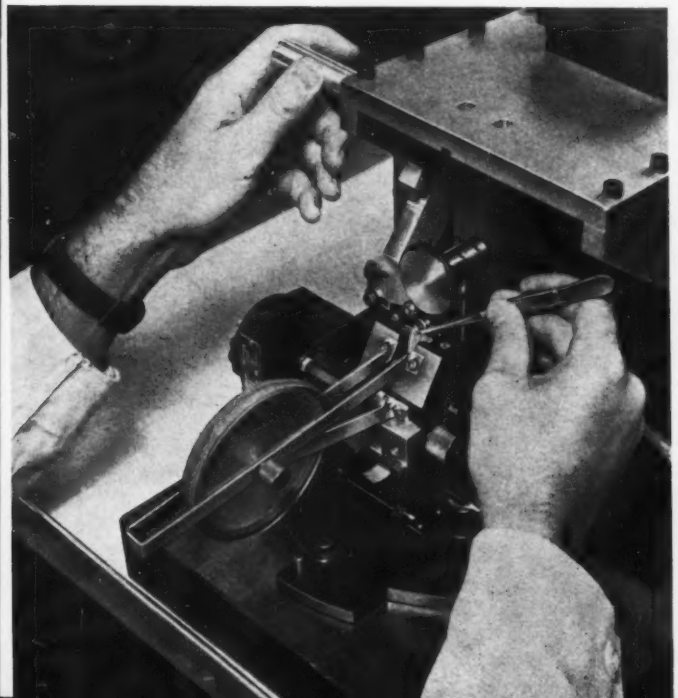


Fig. 8. Inner-ring raceway lapping. The raceway undergoes its first polishing on this motor-driven table-top unit. A rubber-tired wheel turns the ring in contact with a reciprocating, formed backup arbor over which fine-grit emery paper is drawn continuously.

grit emery paper seen supported at the front. Before use, this paper is broken down with the edge of a stone to remove the sharp cutting edges. Then beeswax is applied.

Two rollers driven by a small electric motor pull the abrasive paper over a formed backup arbor beneath the work. The arbor is so shaped that it, plus the paper thickness, will yield a cross-curvature radius of the raceway within 0.001 inch. Metal removal is on the order of 0.0001 inch per side.

A timer limits the operation to one minute with one face out. The part is then reversed in the machine and lapped for a timed interval of one minute with the opposite face out. Experimenting has shown this time cycle to be optimum to obtain a desired degree of finish without adversely affecting roundness or digging into the surface. In other words, established geometry of the raceway is preserved. It should also be pointed out that lapping of the raceway at this point is not done for size considerations.

During the operation a large rubber-tired wheel (seen above work-piece in Fig. 8) rides in the raceway and drives the ring. The abrasive paper is constantly advanced over the arbor while, at the same time, the arbor oscillates back and forth.

Finish lapping of the inner-ring raceway makes use of another small, precision table-top unit, Fig. 9. Here, emery paper is replaced by a fine lapping compound held in contact with the raceway by another formed arbor, or replica. This replica is made of a soft, low-melting-point (136 degrees F.), low-shrinkage material. A completed master bearing ring is used as a mold to cast the replica, thereby assuring proper conformity. In addition, it is soft enough to provide good polishing action.

The inner ring is slipped over a rubber-covered driving rod which rotates it in contact with the soft metal shoe, or replica. Because the ring is a loose fit on the driving rod this is, in reality, a centerless operation, with the ring constantly seeking alignment between the center of the raceway and the replica. Another advantage of being centerless is that the roundness tolerance of 0.000020 inch will not be disturbed.

As was the case during initial lapping with abrasive paper, this also is a timed operation.

Fig. 9. Inner-ring raceway is finish-lapped while roundness is held to 0.000020-inch tolerance. Rubber-covered driving rod rotates ring against soft metal shoe contoured to raceway and held under measured tension by a spring.

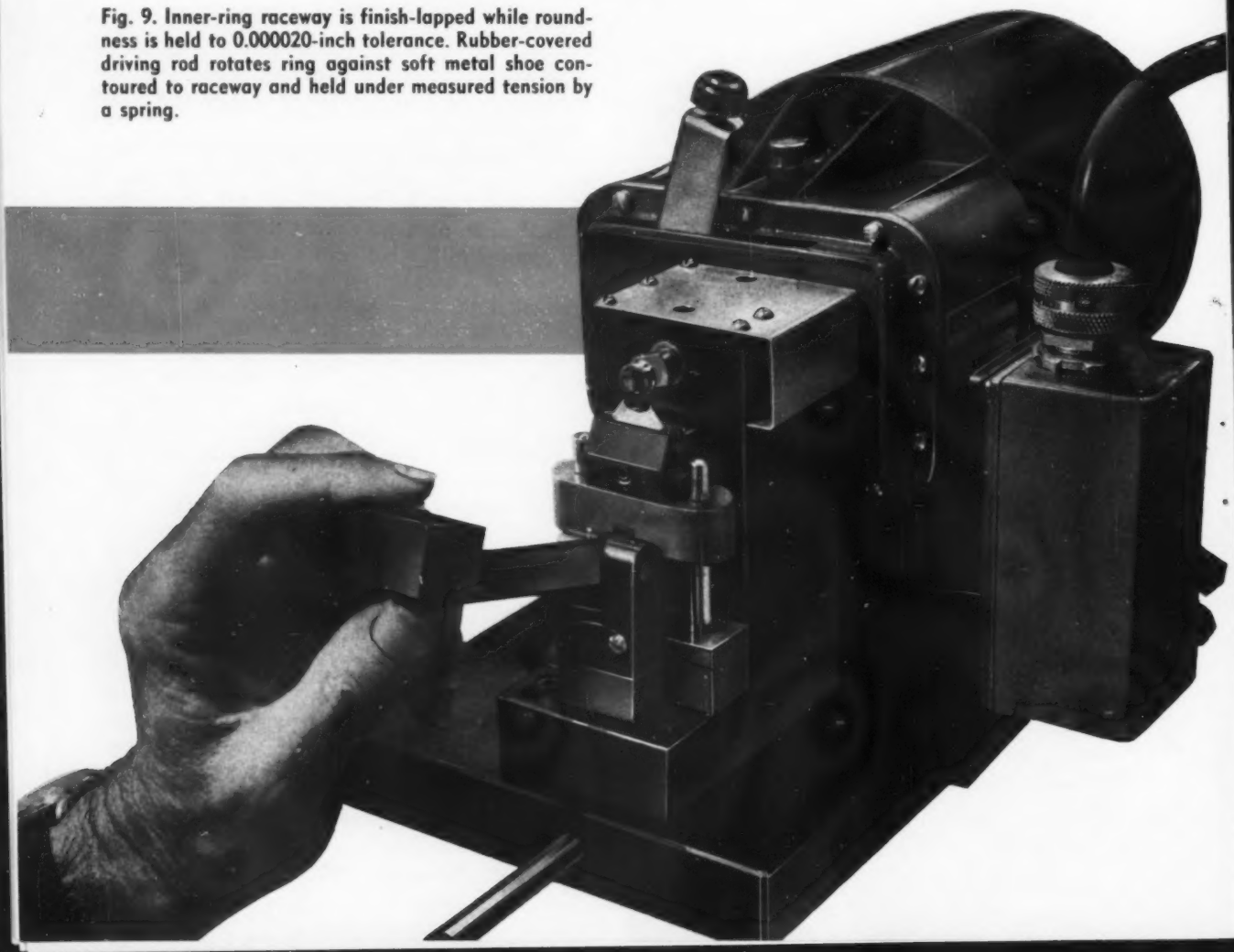


Fig. 10. Eight outer rings are finish-lapped simultaneously to a 0.000040-inch tolerance. Motion is provided by rotation of rings and lateral movement of shoe. The cast-iron lapping shoe, to which compound is applied, is contoured to outside diameter of rings.

Formal inspection is not performed after finish lapping. The only requirement based on this operation is that, measured on a Talyrond, a maximum out-of-roundness of 0.000010 inch, peak to peak, be met. This is a radius measurement, hence one-half of the over-all tolerance on out-of-roundness of diameter.

Switching attention to the outer ring, a peripheral lapping operation is required here too. Scratches and other surface marks are removed on the standard Spitfire precision lapping machine illustrated in Fig. 10.

An arbor of centerless-ground drill rod mounts eight outer rings at one time. The fit is on the loose side, 0.003-inch clearance being allowed between arbor and ring. By placing such a large number of rings on the arbor at one time, squareness with the faces is maintained because they do not have the opportunity to cock. Taper, too, is held to a minimum.

The ground lapping shoe suspended from the operating lever is of cast Meehanite. It is sufficiently long so that it always bears on more than one ring at a time.

After finish-lapping a set of rings to size with A-1 compound in this manual operation the radius of curvature of the rings' periphery becomes slightly smaller than it was at the outset. By the same token, the curvature radius of the lapping shoe is altered—the tendency being to become smaller also. Under these circumstances, were the lap to be placed over a new set of rings, binding would occur. To avoid this, the shoe itself is lapped after each load is completed by running it (with compound) against a length of drill rod ground to the diameter of prelapped outer rings.

It is interesting to note that the rings are sorted, prior to lapping, into ten different size ranges having a separation of 10 to 12 millionths of an inch. This is done to avoid the mounting of "large" and "small" rings on the same arbor—each size group being run separately. Another precaution in the cause of accuracy is maintenance of the lapping rolls. They are lapped in with a third roller at least once each day.

"White Room" Inspection and Assembly Techniques Complement Manufacturing Procedures

Precise manufacturing steps that have brought the inner and outer rings to completion in an unusually refined condition are of little value without the equally exacting inspection, assembly, and testing techniques practiced in the "white

room." In this temperature- and humidity-controlled, dust-free area can be found many instruments and devices developed by Barden engineers to bring the 20-millionths bearings to reality, and to provide the various charts and other "pedigree" documents that will accompany each bearing into the field.

Although many inspection steps are involved, the sequence of gaging is unimportant. In one setup using a Moore air gage, the bores of the inner rings are checked at both ends and in the middle. This yields nominal bore size and taper. The taper must be within 0.000020 inch, but the bore diameter is permitted a leeway of 0.000040 inch because of the tolerance range of the shafts on which the completed bearings will be mounted (selective fittings employed).

Squareness of the bore with one face is ascertained in the setup shown in Fig. 11. (In some end applications, as is the case with this bearing ring, the stamped face serves as a reference face.)

Ring *A* is laid flat on a lapped, ribbed anvil plate and over a stud. An idler roller *B* contacts the ring land and holds it against two carbide balls. These serve as reference points in the lower part of the bore. When a bracket supporting a small motor is pivoted down, rubber drive cylinder *C* causes the inner ring to rotate.

With the bottom of the bore being used for reference, the top of the bore is contacted by the probe tip of an Indi-Ac electronic gaging head *D* which, in turn, feeds information to the Esterline-Angus recorder at the left. Should the bore be leaning out with relation to the face, its upper portion will wobble as it passes by the probe tip (with the bottom of the bore being retained in a fixed position).

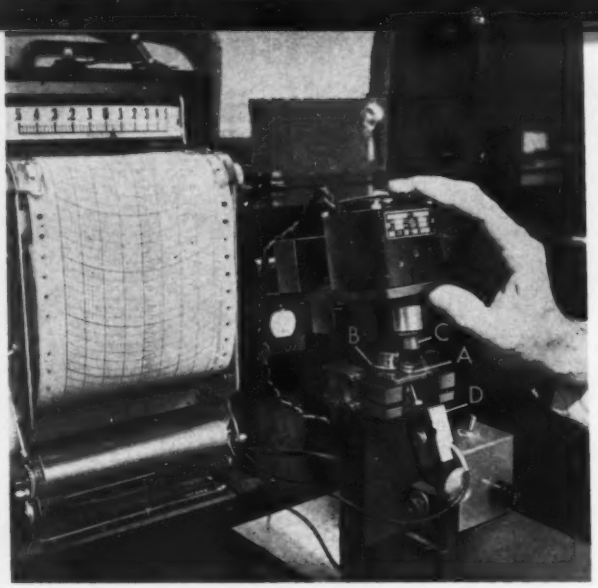


Fig. 11. Inner ring (A) is rotated by a small motor as a probe in its bore senses out-of-squareness variations in relation to reference face. Chart trace is exceeding 0.000020-inch tolerance (two vertical lines), thereby causing rejection of this ring.

If the bore is perfectly square and round the recorder will show a straight-line trace. If perfectly round but out of square, a sine-wave trace will result—one sine wave per revolution of the ring. Peak-to-peak amplitude of the sine wave indicates the degree of out-of-roundness. Each vertical division on the chart paper represents 0.000010 (10 millionths) inch. As can be seen in Fig. 11, the trace extends beyond two division

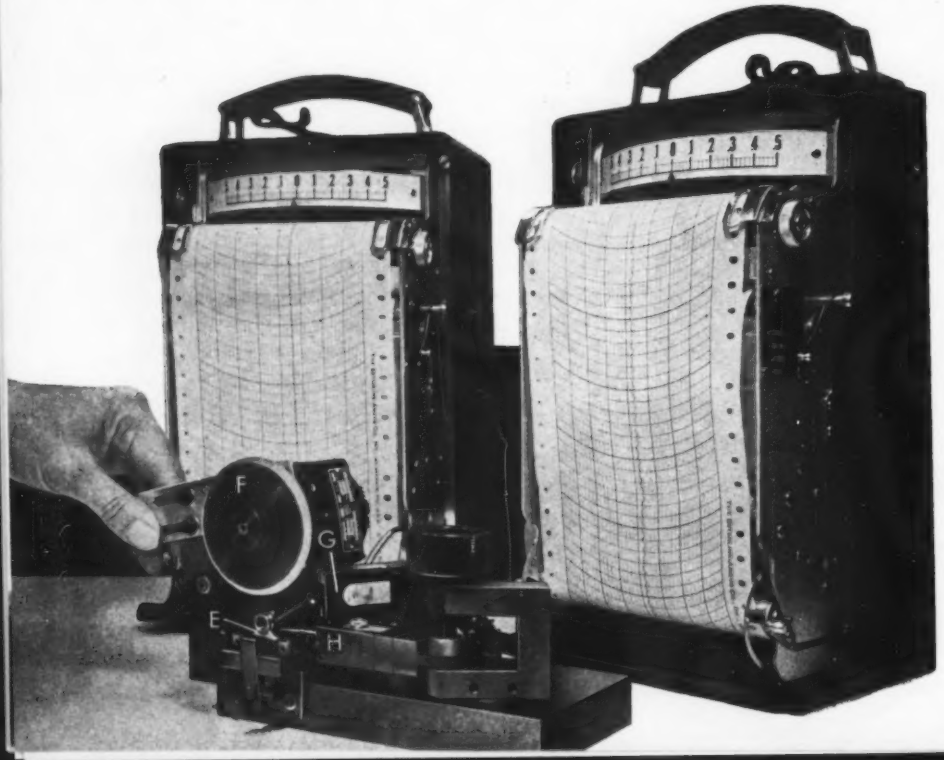


Fig. 12. Motor-driven unit measures parallelism of inner-ring raceway with face at same time that radial runout is gaged. Two electronic gaging heads, (G) and (H), are used. Five vertical lines on recorder charts represent distances of 0.000010 inch.

lines, thereby announcing a bore squareness variation in excess of 0.000020 inch and causing rejection of the ring.

Wobble and eccentricity of the inner-ring raceway are being checked simultaneously on the combination gage shown in Fig. 12. The raceway is constrained, as was the case during final lapping, by a soft metal replica *E* which provides the reference surface from which both measurements are taken. The reference face of the ring (rear in the illustration) rests against a small carbide ball which keeps it in the proper vertical position. A large, rubber-rimmed driving wheel *F* is lowered to turn the ring on the replica.

Two electronic gaging heads are mounted on this checking fixture. Eccentricity is the job of head *G*. The probe tip of this unit extends into the bore and rests against a point opposite the deepest portion of the raceway. Actually, measurement is being made of the thickness of the ring at this point. Roundness has previously been measured and is known to be in tolerance. Therefore, if thickness remains constant around the ring, concentricity must be within the prescribed limits. A trace of this function is recorded on the chart at the left.

The gaging head *H* is turned at a right angle to the first. Its probe bears against the rear, or reference, face as the ring rotates to detect face wobble in relation to the groove. Results of this check can be seen on the chart at the right. Both traces are well within the allowed 0.000020-inch tolerance.

In another check ring width is measured to 0.000005 (5 millionths) inch with a Swedish Microcator lever type gage. Although width tolerance is 0.000040 inch, the actual measurement must be known to 0.000005 inch for proper grinding of spacers when mounting the bearings.

Roundness of both raceways and surface finish of the outer-ring periphery are determined from a Talyrond trace. A plastic template is used having inscribed circles representing divisions of 0.000010 inch. The smallest and largest diameters are measured—the difference between the two being the degree of out-of-roundness.

Both rings are visually checked when they first enter the white room and again after they have been through all gaging operations to be sure there are no scratches or other surface defects. In another step the cross-sectional diameter of the

(Continued on page 110)

FINAL INSPECTION

BARDEN PART NUMBER R4HX17 -20/50 BARDEN SERIAL NUMBER 6744

* 57% O.R. CURVATURE

PARTS

	INNER RING # 10FCI		OUTER RING # 61FBT	
1. Bore Size	.249970 Min. / .249985 Max.	1. O. D. Size	.624915 Min. / .624935 Max.	
2. Bore Roundness	.000010	2. O. D. Roundness	.000005	
3. Bore Taper	.000005	3. O. D. Taper	.000010	
4. Bore Square with Stamped Face	.000020	4. O. D. Square with Stamped Face	.000005	
5. Groove Roundness	.000010	5. Groove Roundness	.000020	
6. Groove Wobble with Stamped Face	.000010	6. Groove Wobble with Stamped Face	.000020	
7. Groove Eccentricity with Bore	.000000	7. Groove Eccentricity with O.D.	.000000	
8. Width	.195700 Max.	8. Width	.195750 Max.	
9. Parallelism of Faces	.000005	9. Parallelism of Faces	.000005	

Nominal Ball Diameter 3/32"

Oil Retention 1.9 mg Oil Bleed-out 0.1 mg

BEARING

1. Contact Angle	32° 55'
2. Preload Offset under 10# Load	-.000160 inch
3. Running Torque under 10# Load	3.0 gm. cm.

Fig. 13. This final inspection sheet is typical of those accompanying 20-millionths bearings into the field. Also included in the pedigree of each bearing are copies of all charts recorded during final inspection of inner and outer rings and assembled bearing.

LAURENCE W. COLLINS, JR.
Associate Editor

Better pipe welds . . . . at 12 miles per hour

JOINTS formerly impossible to weld in either ferrous or nonferrous metals are practical using an ultrahigh-frequency resistance technique. The method is economical for welding pipe and also for jump-welding fins, ribs, or other continuous projections on cylindrical parts or odd forms and shapes to the surface of tubing and flat metal sections at high speeds. Suitable portions of heat convectors, heat exchangers, condensers, refrigerating equipment, structural elements for aircraft, and many other formed or built-up metal combinations can be joined. Many of these, because of their shape, have never been attempted because they seemed "impossible." Assemblies fabricated by costly, slow, or extremely difficult welding or forming methods can also be joined using applications of the Thermatool method and principle, designed by The New Rochelle Thermatool Corporation, New Rochelle, N. Y.

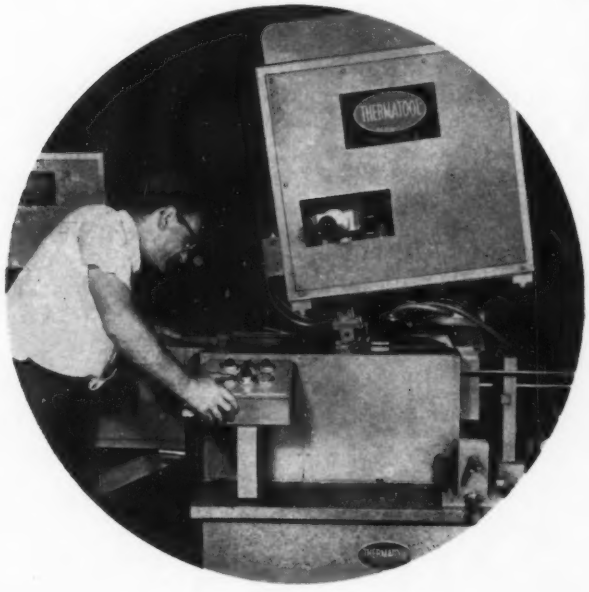
Up to now, continuous-welding procedures, using helium or argon shielding, have been limited by the rate at which heat could be applied. Consequently, only slow or moderately fast linear speeds of production have been possible. High-frequency resistance-welding techniques, on the other hand, produce localized heat having many times the intensity of other fusion methods. Such high heating rates facilitate joining sections which cannot be fabricated at lower heating rates. Thus, 450,000-cycle resistance welding brings to continuous seam welding the same speed potentials, production advantages, and quality which spot welding and impulse welding have provided

for joining metals at highly selective points, and high-quality welds at speeds impractical with any other methods. Also, the thermal conductivity of metal fabrications currently manufactured by soldering, sweating, brazing, or pressing joints can be greatly improved by high-frequency resistance-welding methods.

At the present time, quality tubing of ferrous and nonferrous metals, including 100 per cent pure, high-conductivity copper, stainless, and galvanized steel, hot- and cold-rolled steel, and the rare earth metals such as zirconium and titanium are welded by this method. And joints between metals of different characteristics—for example, copper to steel and high-speed steel to carbon steel—are now routine operations, effective at speeds never before considered practical. The equipment and tooling are versatile, thus the same welding head can be used interchangeably with various metals and alloys to weld continuous mash seams in pipe walls ranging in thickness from 0.004 to 3/8 inch at speeds sometimes as fast as 1000 fpm. Standard tubing is usually seam-welded at 250 fpm.

High-frequency electrical energy applied to seam welding of tubes and strip metal is a new adaptation of the time-honored principle of creating heat by forcing current to flow across a metallic joint. In the newer technique employed by the New Rochelle Thermatool Corporation, the current is caused to reverse at a very much higher rate—450,000 cycles per second—as compared to line frequencies of 60 cycles. Resistance heats the adjacent metal skins to the melting point and pressure then forces the surfaces together. No descaling, flux, or filler rod is needed. But the metal surfaces should be sufficiently free from oil to prevent fires and clean enough to permit electrical contact with the shoe. At high frequency the electric current does not follow the usual direct low-resistance path between the two contacts. Instead, it follows a long path—the lowest possible inductance path—on the skin of the metal. This phenomenon is called narcissism, or the skin effect.

To weld pipe, the edges of the metal to be bonded together are positioned opposite each other as the strip travels through the forming mill. In the case of tubing, the equipment can be any standard forming mill, Fig. 1. But here is one of the main differences between familiar low-frequency resistance pipe welding and this newer method. As the strip moves toward the welding head, the open seam is held to the shape of an elongated vee, the root of which is made to close at a point between the squeeze rolls which effect the weld. The high-frequency current is introduced into the metal by means of a pair of contact shoes which ride one on each side of the open seam, between 1 and 2 inches from the root of the vee, Fig. 2. Each leg of the vee is the return conductor for the other, and heat concentrates at the root, since the narcissism tendency of ultra-high-frequency current flowing in the low-induc-



The skin effect, or "narcissism," of ultrahigh-frequency electric current, once a laboratory curiosity, has been put to work welding tubing at unbelievably rapid speeds. Dissimilar metals are joined and numerous odd sections can be built up with surprising ease using electrical resistance at 450 kc

Fig. 1. (Above) Helical fins are welded to Zircalloy tubing using this special draw-bench. The generator is at the rear.

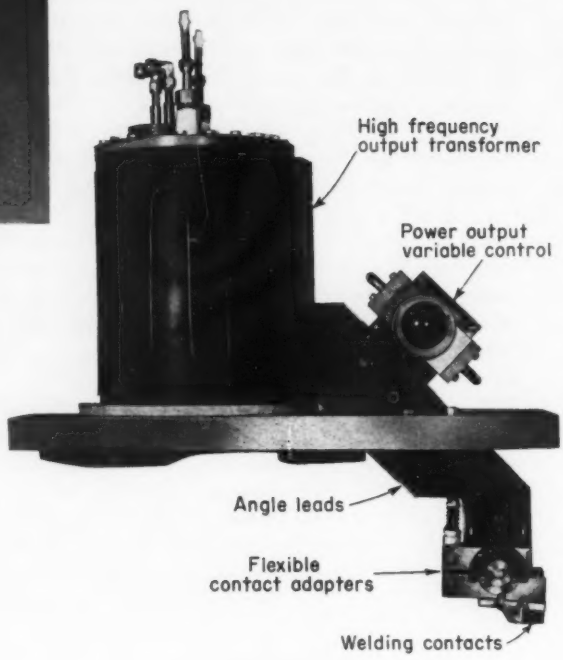
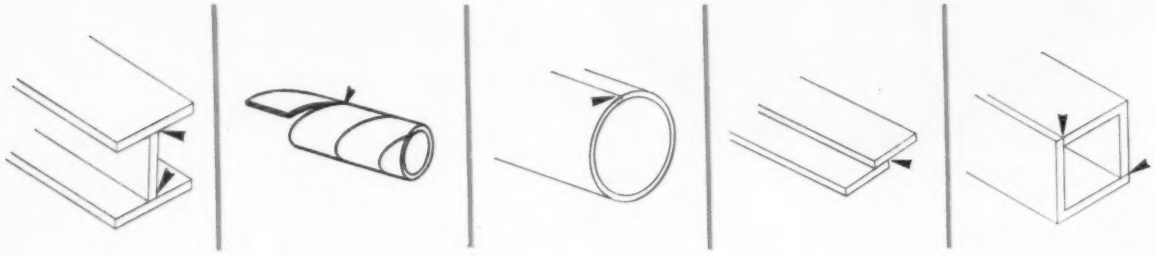


Fig. 2. (Right) The ultrahigh-frequency resistance welder is a relatively straightforward affair. The "business" end is at the lower right.

tance path is to hug the closest surfaces of the material facing each other. These are the surfaces being welded. Thus the skin effect produces localized, high-intensity heating, enabling the edges of the root of the vee to reach welding temperature. Pressure applied at the root of the vee results in a forged weld—lap, mashed-lap, or butt-edge, as desired. The principle makes possible the welding of strip to tube in innumerable useful combinations, as illustrated on the border of this page.

An interesting application of the process involves the welding of a helical Zircalloy fin to the outside wall of a Zircalloy tube which has been previously seam-welded by this method. Because the tube must rotate to permit the fin to be welded helically, this operation obviously cannot be a continuous process, but must of necessity be accomplished on a draw-bench with finite lengths of tubing. Fig. 3 shows, diagrammatically, a draw-bench with a high-frequency resistance welder arranged for the production of spirally finned tubing. Finned Zircalloy tubing welded by this method has been approved for atomic reactors. The equipment is in use at the Hanford, Wash., plant of the Atomic Energy Commission.

In this particular operation (heading illustration) the tube is fed into the draw-bench over a mandrel which supports the tube on the inside and prevents distortion due to the fact that the



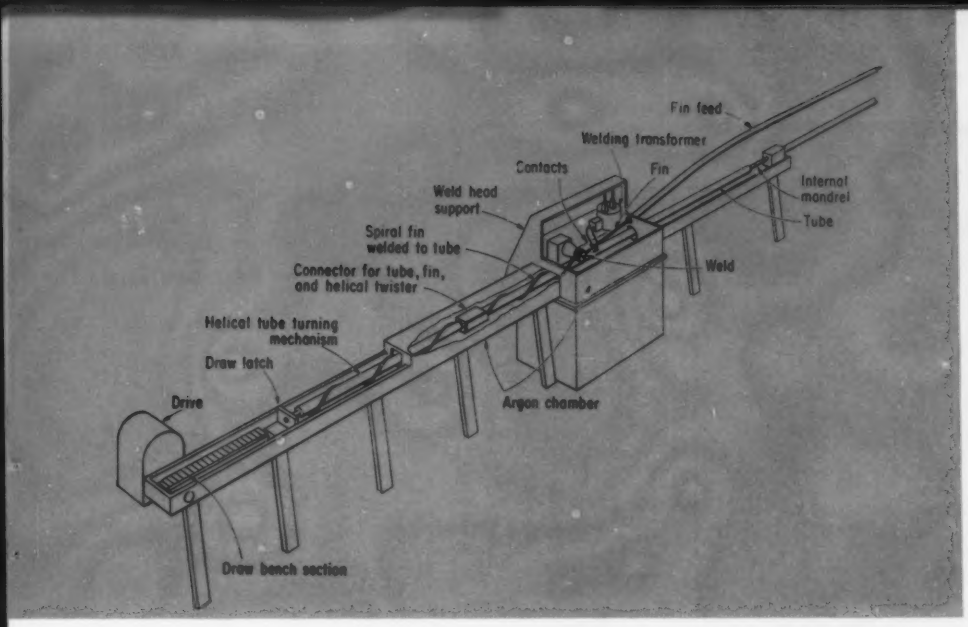


Fig. 3. (Above) Schematic drawing of a typical tube or fin-to-tubing welding setup with draw-bench and cut-away of the inert-gas enclosure.

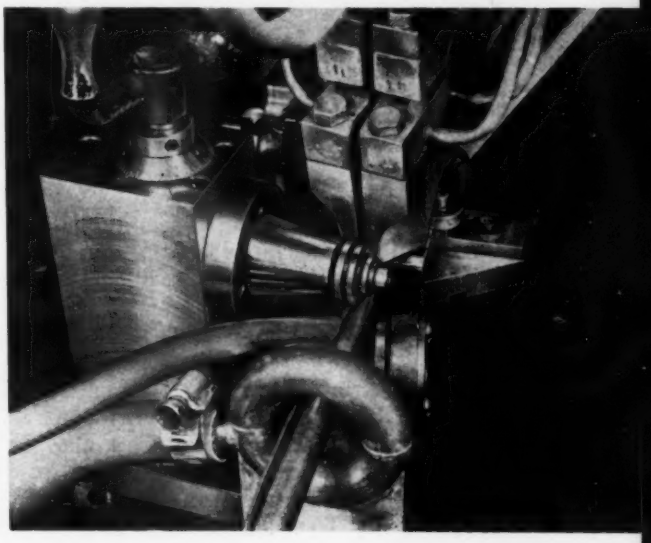


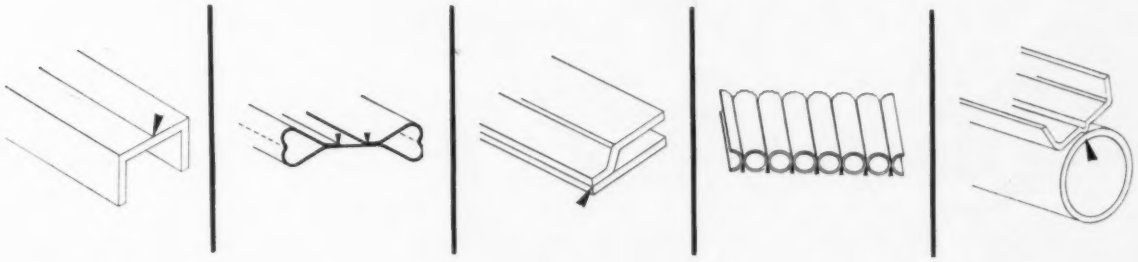
Fig. 4. (Right) Argon gas from the toroidal manifold (foreground) shields the resistance welding of a helical fin to the tube exterior. The welding shoes (top right) are shown raised from the work.

upper squeeze roll, Fig. 4, exerts the pressure used in welding the fin to the tube. The strip of metal to be welded to the tube is introduced through a fin feed, as in Fig. 3, and the tube and fin are brought together as an elongated vee in an argon chamber. One of the contact shoes rides on the tube and the other on the fin to complete a resistance circuit for the high-frequency current, Fig. 5.

In welding some of the rarer metals, a protective atmosphere is necessary. Argon is one of the most effective in creating an inert-gas pocket for the welding operation. The ends of the tube and fin are locked at the connector (Fig. 4) to a specially designed cam-bar, which causes a spiral movement of the tube as it travels longitudinally through the draw-bench.

This process, in addition to welding tubing and strip metal of infinite length, can weld continuous sections such as those at the bottom of this page and pages 90 and 92. Also:

1. Flat strip, channel, or inverted channel to tubing;



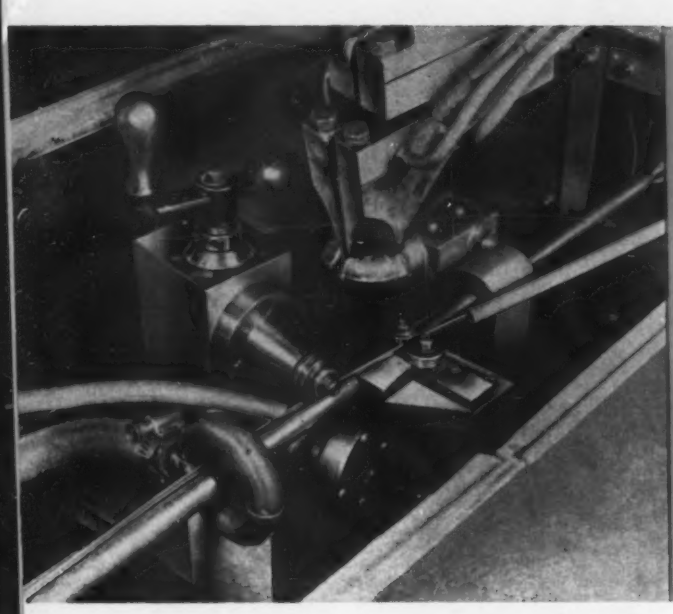


Fig. 5. During welding, contact is made by one shoe on the tubing, the other on the rib, while the pressure roll (center) guides the rib strip and hot-forges it into the skin of the tubing.

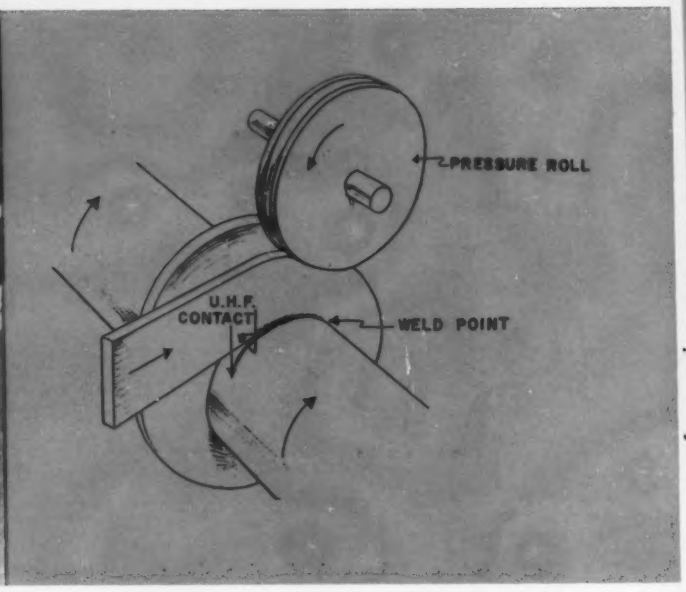


Fig. 6. The joining of a spiral fin to heat-exchanger tubes is the result of changing the helix angle of the pressure roll as compared to that used in Figs. 4 and 5.

2. Corners of square or rectangular tubing;
3. Structural shapes such as I-beams and even double I-beams and box sections that cannot be extruded or drawn;
4. Odd T-sections, either straight or at odd angles;
5. Two-angle strips to build up a channel;
6. Two tubes of different diameters that can be joined to provide a heat-exchange tube that will insure the continuous flow of viscous liquids.

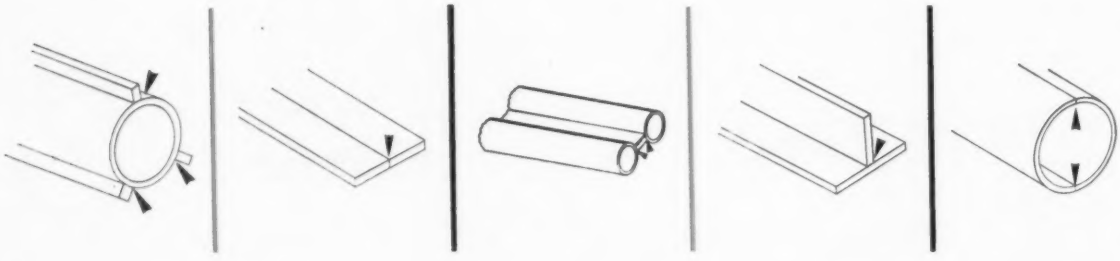
With tubing and strip metal of finite lengths the high-frequency Thermatool can weld:

1. One or more spiral fins on tubing;
2. Lip or edges to seal drum heads, etc.;
3. Tapered tubes—even heavy-gage metal such as used in lampposts;
4. Perforated strip metal;
5. Tubes joined together by a spacer between the walls.

A diagrammatic sketch of the application of a helical fin to tubing is shown in Fig. 6.

Thin metal of 0.004 inch can be mash-welded or mash-lapped with a forge weld at speeds up to 1000 fpm. But, UHF welding is not limited to thin-wall production. Steel 5/8 inch thick, either cold- or hot-rolled, with the scale still on, is currently being welded on a continuous basis at speeds up to 50 fpm.

In those instances where speed is not a vital factor, the process is promising because of its versatility in being able to weld, interchangeably, ferrous and nonferrous metal, plus the fact that the heat-affected zone is smaller than in other known welding methods. Metallurgical tests prove that at 400,000 to 450,000 cycles per second the heat is concentrated on the actual edges of the metal being welded, thus reducing potential distortion in adjacent metal to a minimum.

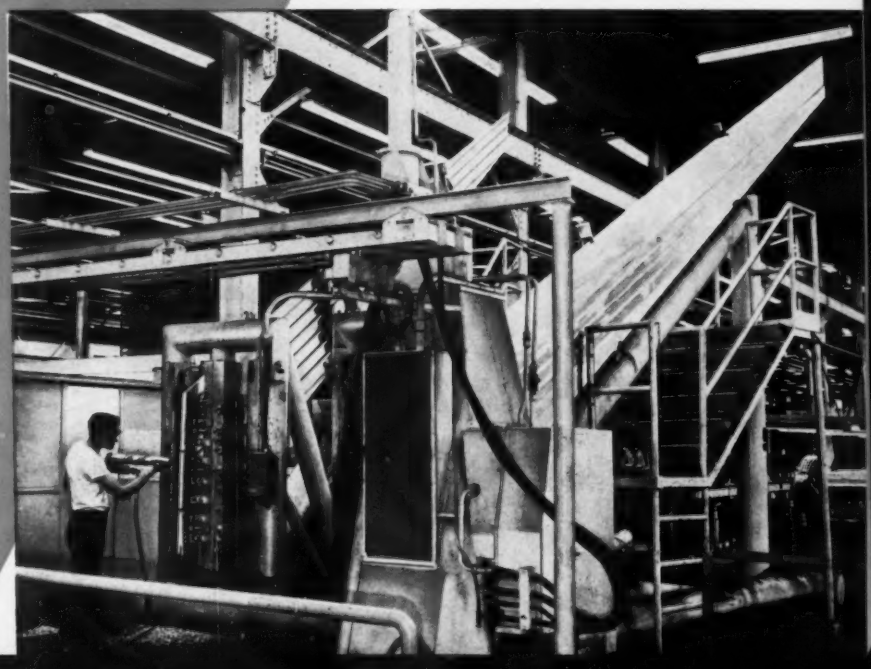


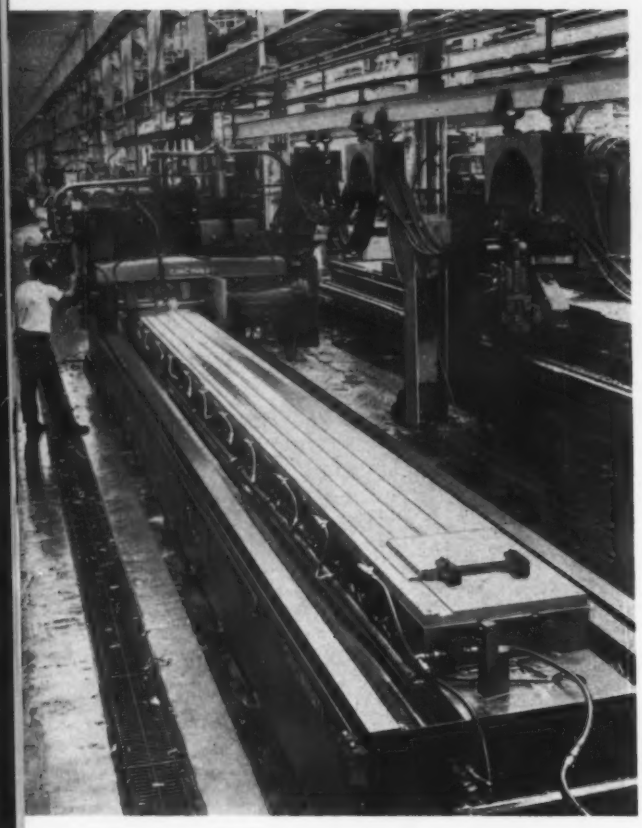
Machining long panels for DC-8 jetliners

Special equipment is necessary for handling three panels as matched sets

THE horizontal stabilizers of the DC-8 Jetliner are those shorter swept-back wings at the rear of the airplane through which the vertical stabilizer and the rudder rise. These stabilizers have a big job to perform. Their strong structure has contributed greatly to the airplane's safety record. They are unique in that the integrally stiffened

C. F. Wallace
Tooling Department
Torrance, Calif., Facility,
El Segundo Division
Douglas Aircraft Co., Inc.





skin panels—the backbone of the stabilizers—are composed of four matched sets of milled aluminum structures. These structures are right- and left-hand and are mounted on the top and bottom of the stabilizer.

The panels start out at the Torrance, Calif., facility of the Douglas Aircraft Co., Inc., as slabs of 75T6 aluminum 1 1/2 inches thick by 16 inches wide by 26 feet long. When the components are finished, approximately 80 per cent of the material has been cut away in the form of chips. The original weight of 600 pounds is reduced to about 125 pounds. The stringers are first milled from these slabs on a Cincinnati horizontal spar milling machine, as seen in Fig. 1. Applying a custom-made carbide cutter at a cutting depth that tapers from 1 5/16 to 1 7/16 inches, the carriage travels at a rate of about 2 1/2 fpm.

Then another long-bedded Cincinnati milling machine equipped with a vertical head cuts a taper along the stringer, under template control. The cutter spindle speed is 3600 rpm.

In order to get the best strength/weight factor, the stringers are undercut with a four-tooth cutter, again on a Cincinnati vertical-head milling machine. A close-up view of the custom-made milling cutter used in this operation is shown in Fig. 2. Here the cut is 0.650 inch deep; the spindle speed, 3600 rpm; and the feed, 2 1/2 fpm.

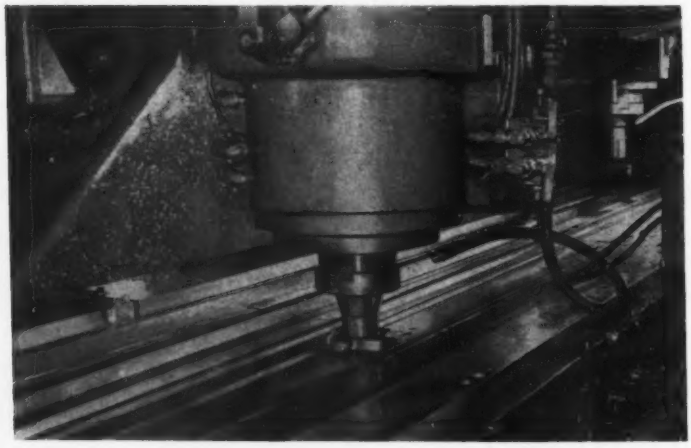
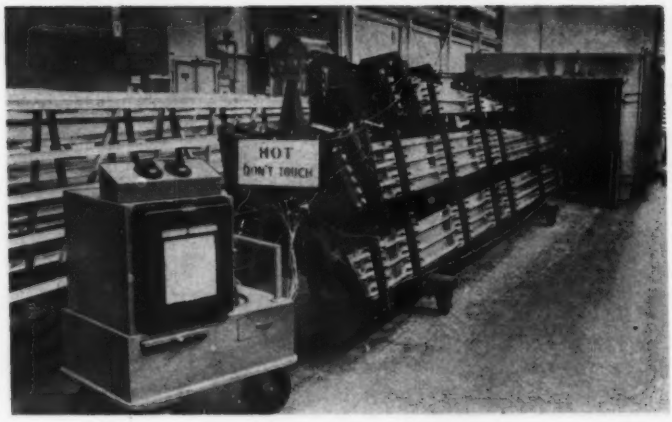


Fig. 1. (Above) One of two long-bed milling machines which produces stabilizer panels from slabs of aluminum 1 1/2 inches thick by 16 inches wide by 26 feet long.

Fig. 2. (Below) Close-up view of operation in which an undercut is milled along a stabilizer panel.



The stabilizer skin panels are then "over-formed" to prescribed radii by clamping in fixtures as shown in Fig. 3 and "soaking" them at 310 degrees F. for one hour and twenty minutes. When air-cooled at room temperature after their release from the fixtures, the parts spring back to the desired conformation.

Three panels of different lengths are then placed in the Douglas-designed milling and drilling fixture shown in the heading illustration. These three skin panels, tapered and in their swept-back position, are milled across the root and drilled for attachment to the inboard stabilizers which are fastened to the fuselage. They are never again separated from each other because from this point on they constitute a matched set. The milling head, with its power source and controls, is mounted on a bed that forms part of the fixture. The machining unit travels on ways to each of four positions as required for the right- and left-hand stringers and for milling top and bottom. In the illustration the milling unit is seen in the foreground.

The milling spindle is driven by a hydraulic motor. The cutter removes metal from the inboard or root section of the panel. Vertical travel of the milling head is derived from a hydraulic ram which provides a 5-foot stroke. A close-up view of the milling operation is shown in Fig. 4.

After the milling has been completed, barrel-nut attachment holes are bored with a portable drill. They are accurately located by bushings in a fixture which extends the full length of the panel root. This fixture is seen at the left in the heading illustration.

After the milling and boring operations have been completed, the mated parts are packed as a unit in returnable, compartmented wooden cases. They are then shipped to the DC-8 assembly area in the Long Beach division of Douglas.

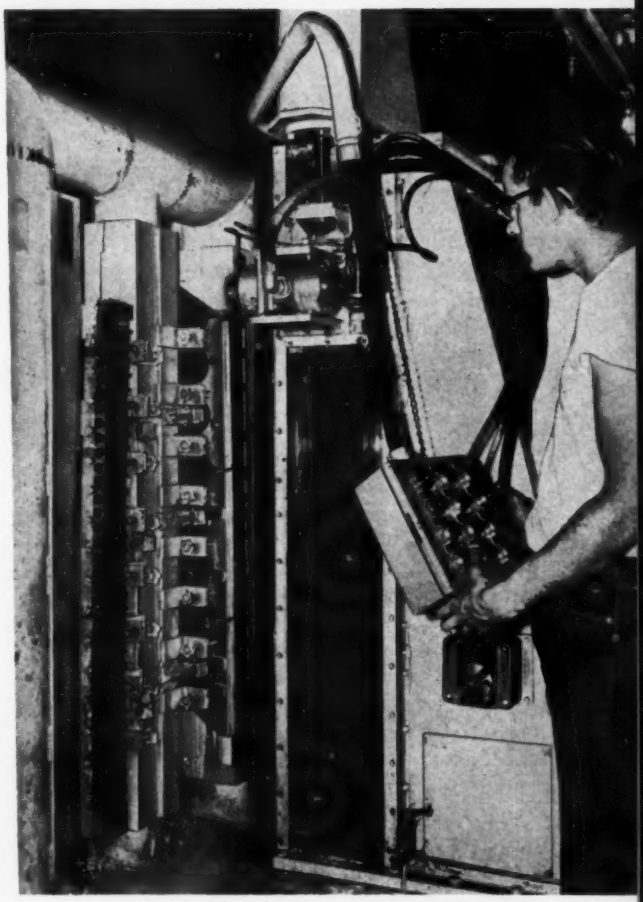
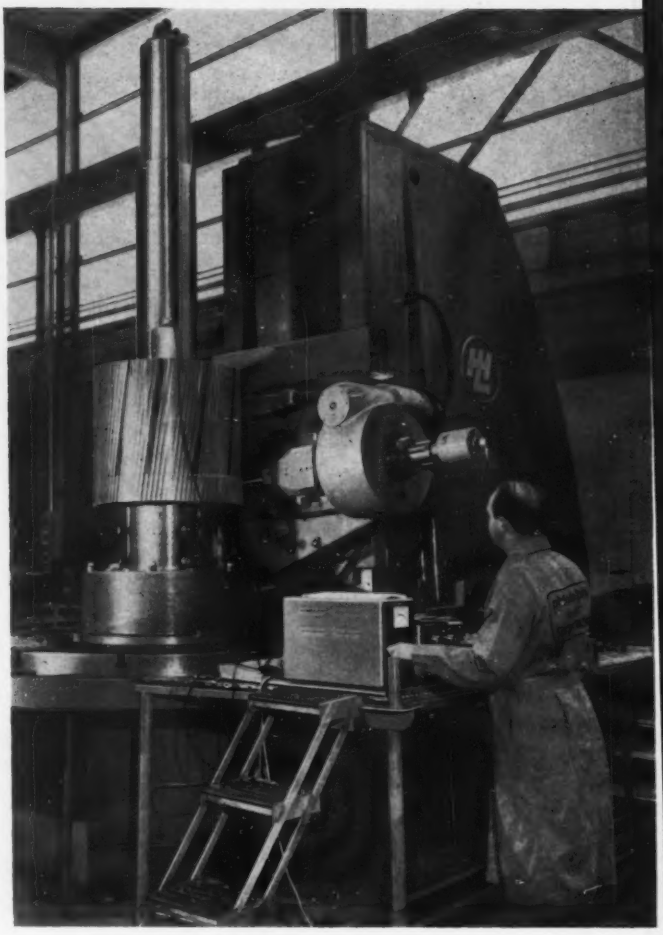


Fig. 3. (Above) Fixtures used to form the stabilizer skin panel to prescribed radii while heated to 310 degrees F.

Fig. 4. (Below) Milling operation performed after heat-treatment of the stabilizer panels preceding boring operations.

LAURENCE W. COLLINS, Jr.
Associate Editor



Tester pinpoints errors in machine tool operation

THE uniformity of gears can be only as precise as the shapers or hobbers used to generate them. When gears run "off spec," all the inspection in the world will not make them right.

How often have you replaced a precision machine tool, or rebuilt one, only to realize from inspection reports that the new equipment could produce parts no better, or even worse, than before? Have you ever had to tighten tolerance on fine-pitch gears, for instance? Have you ever prayed that you could put your finger on the precise part of a machine tool that is pushing up your scrap rate?

These questions are common to many firms making parts whose quality-control specifications must meet standards imposed by the reliability programs of the Armed Services. But they apply anywhere in mass manufacturing. Naturally, emphasis is on the requirements for airborne instrument gears which are increasingly rigid because the space program is trending to deeper and deeper probing. Gear errors of a few seconds of arc in space navigation cannot be tolerated. On the other hand, large herringbone gears for ship propulsion must run increasingly quiet because of the danger of enemy detection.

The challenge of making better gears is broad. Gear hobbers and gear shapers are designed with the capability of producing an infinite number of parts, all exactly like a master. However, in spite of all the good intentions, the thought, and grueling effort, some of the gears are always "better" than others. And among the "good" ones may be one which could cause a missile to fail to leave the pad or miss its target.

Missile failures bring investigations to establish responsibility. One logical object for investigation is naturally the machine tool, since most failures are mechanical. It is one thing to say that a hobber must work better, and quite another thing to be sure that better parts will be made. As a matter of fact, some of the presently requested toler-

Most manufacturers want to know how much error is in precision gear products so that they can correct for the error, rather than to work to a tolerance. New instrumentation in the form of an angular dynamic displacement tester enables the machine tool to be analyzed for the source of error

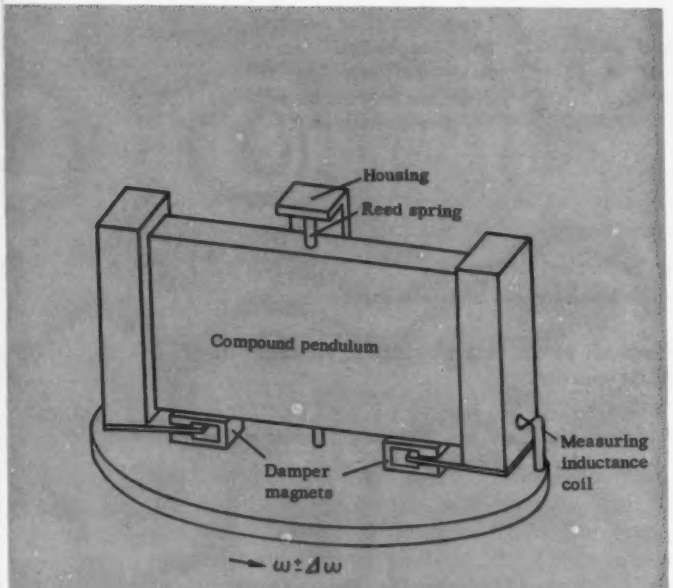


Fig. 1. Simplified sketch of angular dynamic displacement sensing unit with single-reed suspension. Reeds in the prototype are carefully matched and calibrated spring-steel leaves mounted 90 degrees to one another, one pair each at the top and bottom of the pendulum.

ances look as ridiculous as today s run-of-the-mill accuracy appeared only a few years ago.

Fortunately, just when manufacturers think they have reached the limit of feasible accuracy, something new has always come along to enable them to meet the next generation of tolerance requirements. The tightening of tolerances becomes complicated in the case of machine tools, and especially gear-generating equipment, where nonuniformity of operational movements causes errors in the products of the machines. Gear-cutting machines have two or more related motions, and thus the accuracy of the gear produced depends heavily upon the proper operation and synchronization of the several motions. The sources of such errors can be baffling.

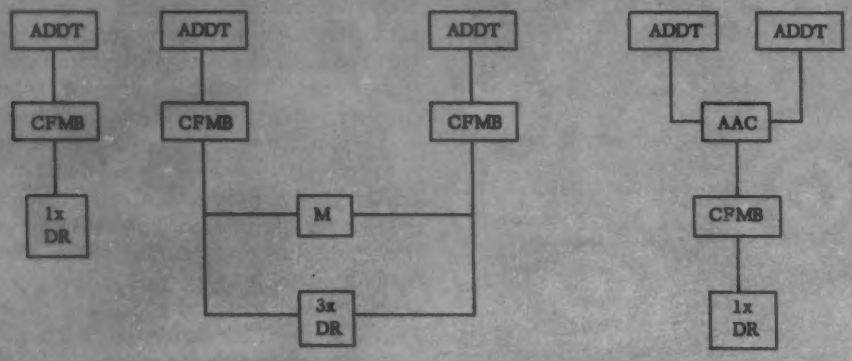
Recognition of the crucial need for the highest accuracy in machine tool motions and their proper synchronization in gear-cutting machinery led the Kurt Orban Co., Inc., Jersey City, N. J., to set up a research and development project which, it was hoped, would solve the gear repeatability problem. Started in 1957 at the University of Aachen, West Germany, a procedure and test equipment have been developed by which gear cutters and other machine tools can be analyzed. The gears they produce can also be checked to limits previously unattainable.

Machine tool elements are designed to move at constant speed. This is an assumption which is never an actuality. Any motion, whether linear or rotary, is always subject to minor accelerations and decelerations.

The operating principle of the new test equipment is that such operating fluctuation of moving parts of any machine can be measured as angular dynamic displacement. These tiny motions can be recorded by a sufficiently sensitive oscillograph. The simultaneous vibrations of two or more synchronized machine movements, if integrated on the same tape, can also be recorded. Analysis, by trained personnel, of the recording reveals significant facts about the machine tool and thus discloses sources of error.

The angular dynamic displacement tester (ADDT), now available, determines nonuniformity in motions of all types of machinery, including gear-cutting equipment. It also performs single-flank roll tests on gears and sprockets, or complete drive units. Electronic equipment —including the carrier-frequency measuring bridge, the low-pass filter, and oscillographs— permits recording the angular dynamic displacement in the form of tracings on a tape which can be calibrated. Where two or more testers are used to check relative displacement, as in the case of gear-cutting equipment or gear drives, an algebraic addition compensator must be used in the system.

Fig. 2. Typical module arrangements for testers.



Checking one rotary or one longitudinal motion and recording the angular dynamic displacement.

Checking two motions—rotary-to-rotary, or longitudinal-to-longitudinal, or rotary-to-longitudinal movement—and recording each individual movement as well as the deviation of one compared to the other.

Checking two motions—rotary-to-rotary, or longitudinal-to-longitudinal movement—and recording the deviations between the relative motions only.

SYMBOLS FOR DIAGRAMS:

ADDT = Angular dynamic displacement tester for rotary or longitudinal motions

CFMB = Carrier-frequency measuring bridge with 5-kc carrier frequency and adjustable input voltages to 12 volts

M = Mixer containing two resisters, the size of which depends on the output resistor of the carrier-frequency measuring bridge and the input resistor of the recorder

AAC = Algebraic addition compensator with matched impedance

x DR = Oscillograph recorder with appropriate number of channels—possibly two 300-cycle channels and a recording width of 3/4 inch, and one 165-cycle channel with 1 1/2-inch recording width

Fig. 3. (Left) Two Model 180 angular dynamic displacement detectors (foreground) with the equipment diagrammed at the right in Fig. 2. At the left is the carrier-frequency amplifier (CFMB) with a measuring bridge circuit. At the center is a highly sensitive multiple-channel oscillograph (DR) having several recording speeds; and on the right, the algebraic addition compensator with its mixer matched to the output of CFMB and oscillograph input.

Fig. 4. (Facing page, top) Angular dynamic displacement test on a small gear hobber, using two ADDT 180 detectors.

Fig. 5. (Facing page, bottom) Oscillograph recording of angular dynamic displacement test of hob spindle and table rotations of a gear-hobbing machine, with the center tracing representing deviation between the two movements.

One of the advantages of the ADDT is the fact that since it does not require any alignment, setup time is brief. Neither index-plates nor friction discs are needed, and thus the tester can be used independent of machine type or size. Tests can be run while machines are idling, or in actual operation under load. The smallest measurable amount is approximately 0.5 second of arc.

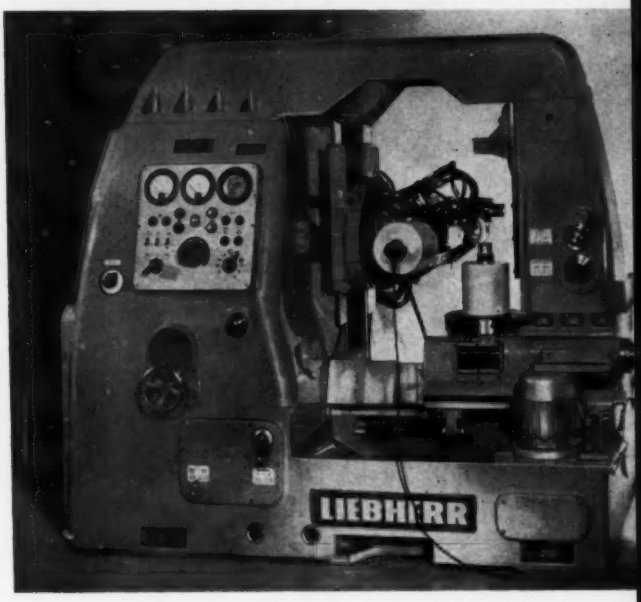
The base of the ADDT sensing unit is either flanged to or can simply stand on the object to be measured and, therefore, goes through all the same movements as the test object itself. The sensing element is a device resembling an accelerometer, but many times more sensitive, Fig. 1. Within the housing an inertial mass in the form of a compound pendulum is suspended friction-free by means of a crossed-reed system, forming a uniform rotary reference movement. The relative movement, if any, between the housing and the inertial mass constitutes the nonuniformity of motion, which is transmitted inductively as an electric signal. Using additional electronic components, these signals can be recorded in graph form on a tape.

The deviations between two rotary or longitudinal motions, or between one rotary and one longitudinal motion, can also be determined when passing the signals from the detector through an algebraic addition compensator. Of course, both detecting and compensating units must have identical natural frequency, damping, and impedance.

The ADDT sensing elements are available in both rotary and linear versions. The rotary type is most applicable to gear-cutting machines, since rotating elements such as gear trains and spindles are significant factors in the operation of the machines. Typical arrangements of the testing elements are shown in Fig. 2. The elements making up the system shown at the right in Fig. 2 appear in Fig. 3. It should be noted that the oscillograph is an extremely sensitive unit with several tape speeds. It is accurate to 1 per cent over its full measuring range.

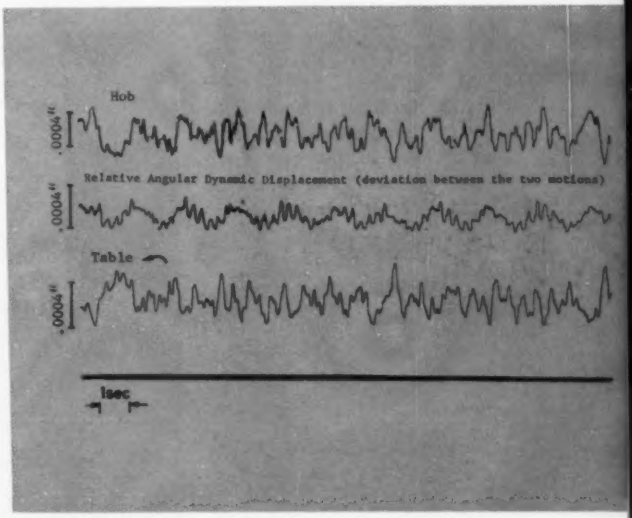
The detecting units, because of their vertical suspension, show greatest sensitivity when mounted with their axes in the vertical plane. In a test setup such as that shown on the small hobber in Fig. 4, one unit is mounted vertically on the table while the other is horizontally flanged to the hob spindle. The wire leads are connected to a slip-ring head so that the detectors can rotate indefinitely. The manufacturer of the test equipment is S & F (Schoppe & Fraeser) of West Germany, and the importer is the Manufacturing Research & Gear Laboratory of Kurt Orban Co., Inc., Parsippany, N. J.

Fig. 4 and the heading illustration show the angular dynamic displacement testers, Type



ADDT 180, mounted on gear-hobbing machines. Fig. 5 shows the deviation in angular dynamic displacement obtained with the component setup diagrammed at the center in Fig. 2, in which testers are attached to both the table and hob spindle. This hookup also shows the variation in the angular dynamic displacement between the two motions, graphically recording the accuracy of the machine.

Arrangements of the test equipment can be used for parts-inspection purposes, where the object is to determine what deviations in generating motion may have caused errors. Two ADDT sensing units are used in the system whose kinematics are shown in Fig. 6, for gear cutters such



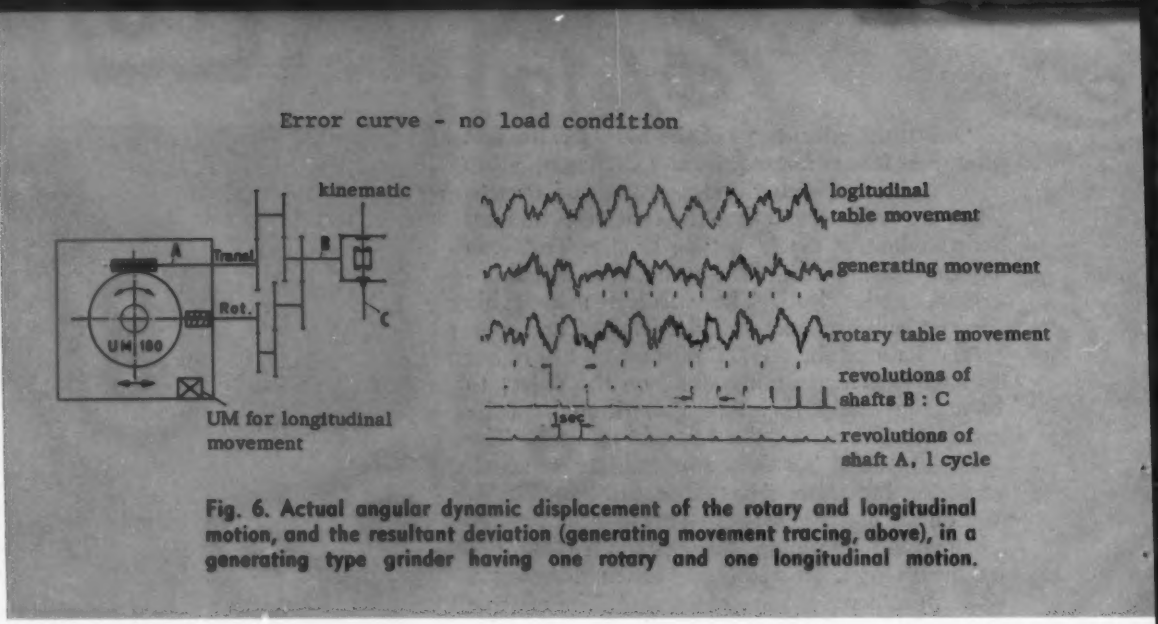


Fig. 6. Actual angular dynamic displacement of the rotary and longitudinal motion, and the resultant deviation (generating movement tracing, above), in a generating type grinder having one rotary and one longitudinal motion.

as those built by Maag of Switzerland. The oscillograph tracings show that the rotary as well as the longitudinal motions have an error with the frequency of shafts *B* and *C*. However, the error, in the differentiation, corresponding to the accuracy of the machine, is being compensated. On the other hand, the deviation causing the main error is in worm-shaft *A*.

The testers permit the single-flank roll testing of individual pairs of gears and sprockets as well as of complete gear-boxes. Since testing can be performed on machines under actual loaded conditions, the influence of tooth deformation and axial dislocations is included in the error pattern. The result is, therefore, an analysis of actual operating characteristics, Fig. 7. Factors in the analysis of a single-flank roll test of a typical bevel- to spur-gear train are shown in Fig. 8. The patterns at the top were recorded by the S & F oscillograph. In addition to the errors of the rotary frequencies in *A* and *B*, angular dynamic displacement is displayed with double the rotary frequency of spur gear *C* and three times the pressure-angle frequency of the spur gear as determined by the sonic analysis.

The ADDT 180 detectors illustrated are pilot units designed and rated for measuring angular dynamic displacement of rotating members turning at speeds between 60 and 500 rpm. The units are designed with a natural frequency of 1 cycle per second and approximately 0.55-ohm impedance. Measuring range in frequency or rpm, shown in the graph, considering the error limits furnished with the frequency response curve of 1 cycle per second, is 60 rpm to 8.5 cycles or 510 rpm. The system has a maximum amplitude of

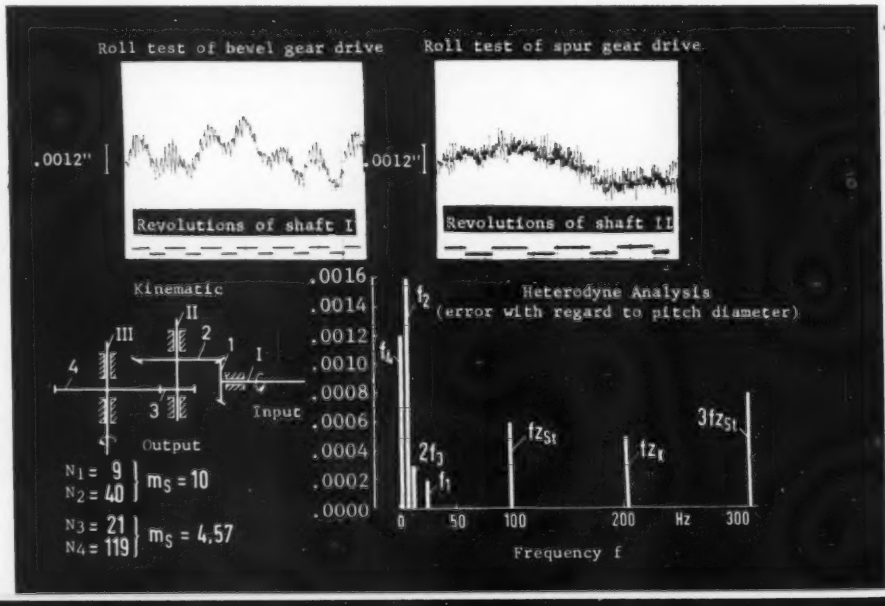


Fig. 8. Heterodyne analysis of single-flank roll test of a bevel- to spur-gear drive pinpoints the source of error in a gear train.

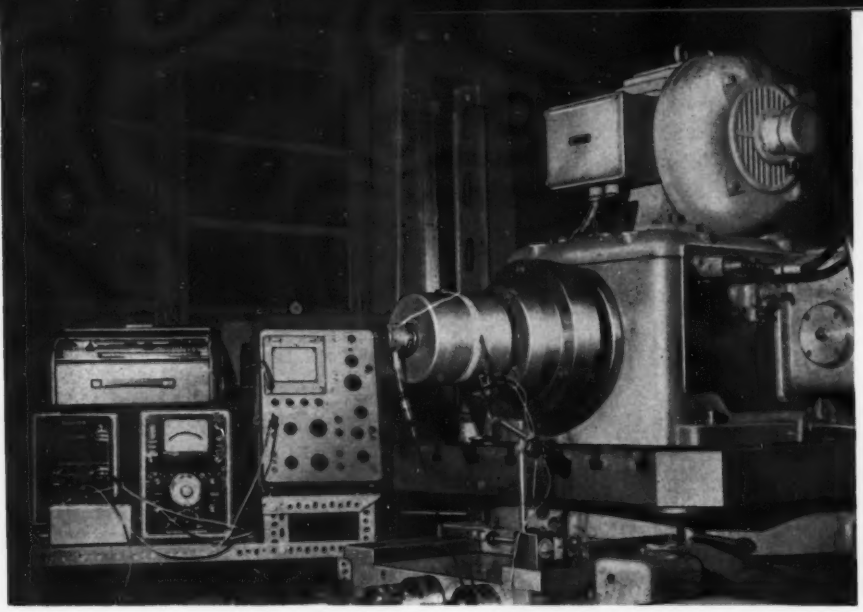


Fig. 7. Single-flank roll test of a gear-box showing a typical setup for checking out a lathe headstock.

±0.008 inch with reference to a test radius of 2.795 inches. The minimum capability of the pilot instrument system is approximately 0.5 second of arc. Linearity is 1 per cent or better. Static characteristic error on a vertical axis is ±0.000002 inch maximum, and ±0.000/30 inch maximum, horizontally.

Dynamic characteristic error, depending on the static characteristic error, follows a curve furnished with the equipment. A typical chart is shown in Fig. 9. The sensing units require connection to a carrier-frequency measuring bridge with 5- to 12-volt input at 4 to 10 kc.

Accuracy of the oscillograph is ±1 per cent over the full measuring range. Frequency response is 110 cycles per second.

Organizations making and using large quantities of precision gears may consider capital investment in outright ownership of ADDT equipment for their own reliability or quality-control laboratories. Obviously, this implies assignment of one or more engineers or technicians trained to use the testing equipment and to analyze the results of tests on machinery and gear products.

In the case of those wishing to evaluate the merits of this mode of testing, or firms which cannot justify the capital investment, the Manufacturing Research & Gear Laboratory of the Kurt Orban Co., Inc., offers testing and analysis as a consulting service. This would entail sending a trained technician with the test equipment into the field to run the measuring operations at the client's plant. The tapes would then be returned to the Orban gear laboratory for analysis. A written report would finally be issued to the client with an interpretation of the test findings.

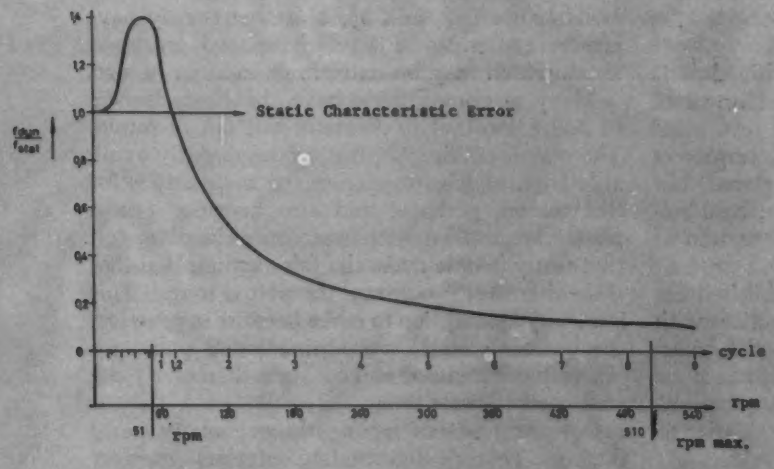


Fig. 9. Typical dynamic characteristic error curve is furnished with each detecting unit of the angular dynamic displacement test system.

Out-of-roundness of machined parts

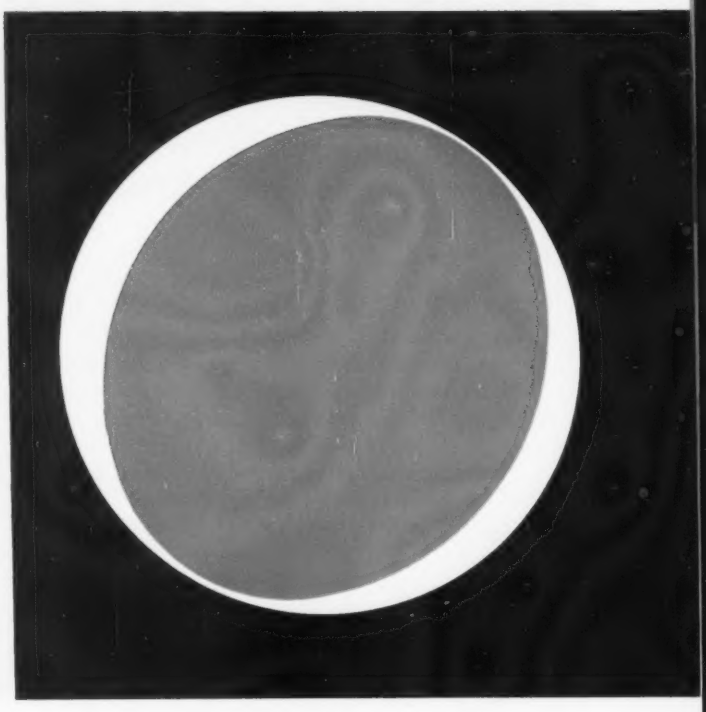
EARL E. LINDBERG
General Motors Research Laboratories
Detroit, Mich.

RECENT demands for improved product performance have brought about a need for accurately controlling the roundness of machined parts. Depending upon the eventual end use of an assembly or a particular component, many parts must be made round within strict tolerance limits for a number of reasons.

For example, if journal bearings are to carry high loads and to resist wear, the journal must be round. Some precision spindles which use journal bearings must have a round shaft to assure a fixed axis of rotation. Hydraulic valve spools and bodies, diesel-engine injector plungers and bushings, and hydraulic lash-adjustor parts must be round to reduce the leakage area to a minimum and yet allow enough clearance so that the parts can be assembled and operated satisfactorily. Ball and roller bearings must have round parts to reduce noise and vibration, to increase life, and to provide a constant torque to rotate the bearings and ensure good axial fixation. Shafts and bores subject to press fits with critical mating parts must be round to avoid distortion of these parts and, in turn, prevent consequent degradation of performance. Surfaces that run in contact with seals must be round to avoid leakage and short seal life.

To understand the concept of roundness as it applies to machining operations—and, in particular, to centerless grinding operations—an elaboration of some fundamental definitions of surfaces and surfaces of revolution, together with a definition as to what is meant by out-of-roundness, is given in the accompanying table.

Fundamentally, the majority of machined parts having curved surfaces can have part or all of their surfaces classified as surfaces of revolution and, if perfectly made, are round. Examples of parts that when perfectly made are round, but are not surfaces of revolution, include: bent rollers, round wire springs (in the cross section of the wire), and curved pipe. Parts that are not round in terms of the definition established for out-of-roundness (see table) include helixes with representative parts being bolts and coil springs. Surfaces represented by oblique cylinders or oblique cones which can have round sections are not round, since the axis is not perpendicular to the round section.



Out-of-Round Parts Can Have a Constant Diameter

There are many out-of-round parts that have a constant diameter in either two or three dimensions (Figs. 1, 2, and 3). These parts may have either regularly or irregularly spaced protuberances which may be uniform or random in size.

Many machined parts have the characteristic of being constant in diameter but out of round. The center of the part is not conveniently available from which to measure the radius. It is for this reason, perhaps, and also because it is a relatively simple matter to measure the diameter, that many people make the false assumption that if the diameter is constant the part is round. This is an easy assumption to make because in practice, the out-of-round effects of machined parts are not very pronounced and constant-diameter parts are nearer a circle.

Out-of-roundness frequently occurs on parts that are centerless-ground. Centerless grinders

Making many diameter measurements of a machined part is not sufficient to determine whether it is round or out of round. In the past, parts were inspected in a V-block in conjunction with a suitable indicator. Recent demands by industry have increased the need for knowing the exact deviation of a part from being perfectly round. This need is being met by roundness-measuring instruments which determine the deviation of a machined surface from the axis of a very precise spindle. Although instruments for measuring out-of-roundness have been highly developed, there are certain precautions that must be taken. For example, the axis of the part must be aligned with the axis of the precision spindle, and out-of-roundness must be differentiated from surface roughness or waviness

FUNDAMENTAL DEFINITIONS OF GEOMETRICAL SHAPES AND OUT-OF-ROUNDNESS

Circle

A closed plane curve all points of which are equidistant from a fixed point, the center, in the plane.

Round Surface

A surface such that each point on the surface lies on some cross section that is a circle. The locus of the centers of these circles is everywhere perpendicular to the plane of the cross section.

Surface of Revolution

A round surface for which the axis is a straight line.

Axis of a Round Surface

The locus of centers of the cross section. The axis is a straight line for surfaces of revolution.

Sphere

A surface of revolution that is generated by the revolving of a circle (the generator) about one of its diameters which is employed as the axis.

Right Circular Cylinder

A surface of revolution generated by revolving a parallel straight line (the generator) about the axis.

Right Circular Cone

A surface of revolution generated about the axis by a straight line (the generator) that intersects the axis.

Out-of-Roundness

The out-of-roundness of the two-dimensional cross section of a three-dimensional surface may be defined as follows: Using each point within the closed two-dimensional curve as the center, it is possible to construct a largest inscribed circle and a smallest inscribed circle. There is a point for which the difference between the two radii is a minimum. That point is called the center of the cross section, and the difference of the radii is called the out-of-roundness of the cross section.

operate primarily on the basis of making constant-diameter parts and, secondarily, on making them round. The less-refined conditions of operation produce parts having three, five, or seven equally spaced lobes superimposed on the round surface. As the operation becomes more refined and the tolerance versus diameter is reduced, the surface becomes more irregular. The surface, however, is still essentially of constant diameter.

Measuring Out-of-Roundness With V-Blocks and Ring Gages

It is impossible to measure the out-of-roundness by measuring multiple diameters. As a result, various devices—notably the V-block and ring gage—have been devised in an attempt to determine the out-of-roundness of machined parts. These devices usually consist of indicating the diameter of the part at several points when using as a reference some average of the general area being measured.

To detect and measure the uniform multiple-lobing effect produced on a part, it is first placed in a V-block having an appropriate included angle between the surfaces of the vee for the number of lobes in the circumference. The part is then rotated and the region opposite the V-block is checked with a suitable indicator.

The optimum included angle for the V-block for each of the more common lobe conditions is: 60 degrees for three-lobed parts, 108 degrees for five-lobed parts, and 128 4/7 degrees for seven-lobed parts.

V-block measurement is most effective when (a) the parts are basically right circular cylinders, (b) the lobes are uniform, and (c) the number of lobes is known.

A technique that works quite well and is useful for determining the out-of-roundness of basic right circular cylinders machined integrally with bulky pieces (such as the journal of a crankshaft) is to fit a split ring gage over the cylinder. If the ring gage is round and if the fit is correct, the

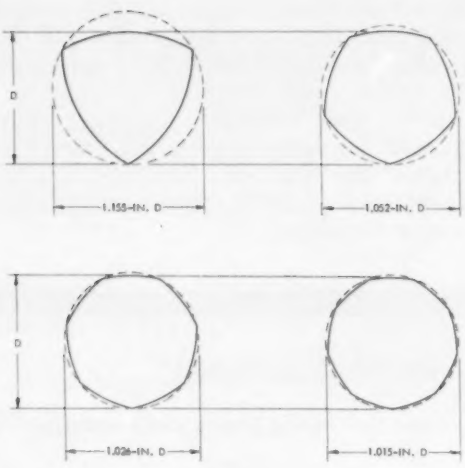


Fig. 1. (Left) Here are extreme cases of isodiametric, multiple-sided parts that are of constant "diameter" (D) in two dimensions, as might be measured by a vernier caliper or height gage, but are not round by the definition given in the table. The number of undulations is odd, each corner is the center of the radius for the opposite side, and the radius is equal to the diameter. In these extreme cases, for a part of 1-inch diameter the smallest circle that can encompass the part is 1.555-inch diameter for three undulations, 1.052-inch diameter for five undulations, 1.026-inch diameter for seven undulations, and 1.015-inch diameter for nine undulations. Fig. 2. (Right) In practice, the out-of-round effects are not so pronounced and constant-diameter parts are nearer to a circle, as illustrated by these shapes which show the transition from the out-of-round to the round isodiametric condition. If radius $R_2 = 0$, the most severe case of out-of-roundness is present. If radius R_1 = radius R_2, the shape is a circle. The diameter of the shape is equal to $R_1 + R_2$.

ring gage can be rotated with respect to the cylinder being measured and the axis of the ring gage will be fixed. An indicator is then mounted to detect radial deviation of the circumference of the cylinder with respect to the ring gage.

The disadvantage of ring-gage measurement is that each size piece to be measured requires an accurately made ring gage.

Highest Accuracy Obtained from Precision Spindle Instruments

During the past decade, new instruments have been developed specifically for measuring out-of-roundness. These devices, referred to as precision spindle instruments, have proved to be most effective for accurately measuring any part having a round surface.

The essential components of a precision spindle instrument consist of a very precise spindle to provide a reference center, a centering device to align the axis of the spindle with the axis of the part being measured, and a suitable indicator which may be coupled with a recorder to measure deviations of the part from roundness.

There are two basic types of precision spindle instruments (Fig. 4) for measuring out-of-roundness. The first type permits the part to be measured to be rotated by the precision spindle. In the second type the indicator is rotated about the part being measured. Each type has its advantages and disadvantages. The choice between the two must, in part, take into account the kind of piece being measured.

A roundness-measuring instrument of the precision spindle type has been designed and built by the General Motors Research Laboratories. Called the GM Roundicator (Fig. 5), it is of the type shown at the right in Fig. 4 and can accommodate parts ranging in size from small needle-bearing rollers to cylinder bores of diesel engines. The axis of the lapped spindle is held both concentrically and axially to an accuracy of less than 2 millionths of an inch by specially designed frictionless hydrostatic bearings.

Circular Chart Shows Manner of Out-of-Roundness

Since it is important to know the manner of the out-of-roundness, the output of precision spindle instruments usually is in the form of a graph. The graph may be recorded on either a circular chart or a strip chart. Typical circular charts produced on a GM Roundicator are shown on page 107.

The chart produced by precision spindle instruments is highly distorted. The height of the out-of-round irregularities is much more highly magnified than their width. It is also necessary for the zero to be depressed to the extent that the deviations from roundness occupy a consider-

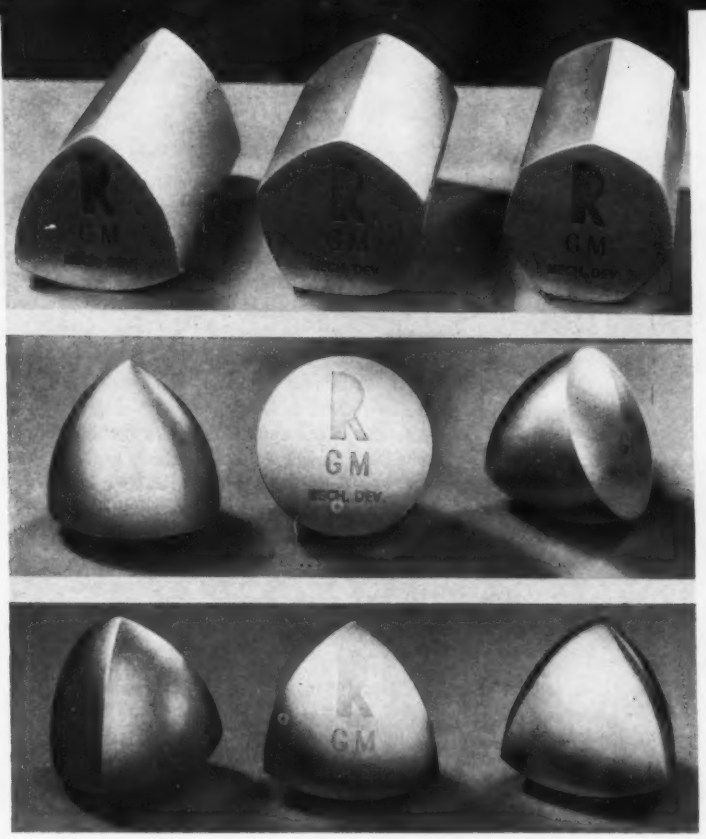


Fig. 3. Examples of isodiametric, out-of-round parts are shown at the top. These constant-diameter "rollers" when placed between two flat surfaces would produce a deceptively smooth motion, allowing the upper surface to travel in a horizontal plane with no vertical component of motion.

As might be expected, there also are out-of-round parts of constant diameter in three dimensions (center). These, when observed on their axis, look like a circle. When the parts are viewed perpendicular to their axis, they have the characteristic shape shown at the top left in Fig. 1.

It might be expected, also, that a tetrahedron with curved faces would have a constant diameter. The diameter, however, is not quite constant. Three of the six edges must be modified with a radius to give a constant diameter. The isodiametric tetrahedrons shown at the bottom have the modified edges. Either of these shapes when used as balls between two flat surfaces allow very smooth two-dimensional motion of one surface with respect to the other. They do not make good bearing balls, however, since the center of gravity is constantly changing and some areas are more highly loaded than when a ball is used.

able amount of the chart width. This is done to make the deviations easily detectable and to allow the chart paper to be of reasonable size. Since the chart is quite distorted, certain fundamental concepts must be applied to determine the shape of the part when evaluating its chart.

The circular chart, when used for recording out-of-roundness, has certain properties that have been elaborated upon by R. E. Reason *(The Talyrond Handbook)*, as follows:

1. The angular relationship of the protuberances of the part is preserved with respect to the center of the chart.

2. In the event that the part is not perfectly centered in the instrument, either best-fitting circles can be constructed on the chart according to the out-of-roundness definition or a circular template may be fitted with very little error introduced for measurements taken in a radial direction. The maximum radial error is on the order of 1/2 per cent of the radius of the recording, if the eccentricity of the fitted circle with respect to the chart is 10 per cent of the recording, and 2 per cent for 20 per cent eccentricity.

3. Differences in diameter of the part are determined by measuring the differences in the diameter of the recording through the center of the chart. This is true regardless of how poorly the part is centered in the instrument.

The horizontal amplification of a strip chart is not inherently limited as in the case of the circular chart. This property of the strip chart is useful when it becomes necessary to examine the fine detail of the roughness that is present on the surface of a part.

Conclusions

The definition given for out-of-roundness in the table has the following advantages:

1. When measured from the defined center, the out-of-roundness can be determined conveniently from a circular chart, strip chart, or displacement indicator.

2. The definition is amenable to instrumentation which is either manually or automatically operated.

3. The minimum amount of metal that must be removed from the part to make it round is immediately evident.

Although instruments for measuring out-of-roundness have been developed to the point where roundness deviations on the order of millionths of an inch can be measured, certain areas relating to out-of-roundness measurement work still remain to be investigated. These include:

1. How to differentiate between out-of-roundness, waviness, and surface roughness.

2. How to define the out-of-roundness of a part which is basically the segment of a circle.

3. How to specify the type and frequency of lobing that is particularly undesirable in round

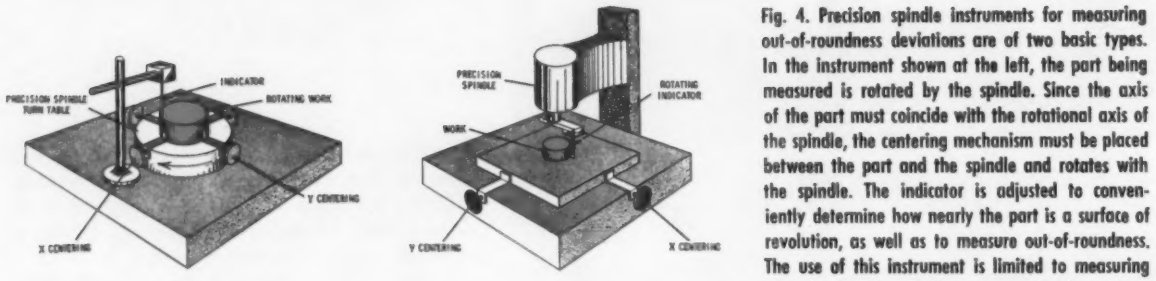


Fig. 4. Precision spindle instruments for measuring out-of-roundness deviations are of two basic types. In the instrument shown at the left, the part being measured is rotated by the spindle. Since the axis of the part must coincide with the rotational axis of the spindle, the centering mechanism must be placed between the part and the spindle and rotates with the spindle. The indicator is adjusted to conveniently determine how nearly the part is a surface of revolution, as well as to measure out-of-roundness. The use of this instrument is limited to measuring of parts that the spindle can conveniently support. The type of precision spindle instrument at the right rotates the indicator about the work. Provision is made to adjust the indicator to accommodate the part being measured, but the centering mechanism is stationary. The part can be large and heavy, the size being limited only by the clearances of the machine. Measurements of the deviation from a surface of revolution can be made, but with more difficulty than out-of-roundness.

parts which must perform under critical operating conditions.

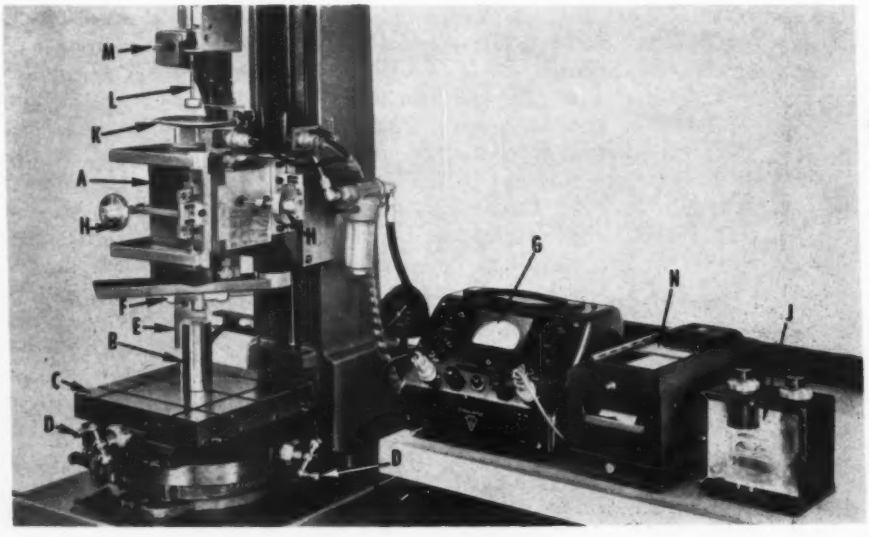
There is one final point which should be considered in regard to out-of-roundness. The engineering drawing serves as the means for communicating to those in manufacturing how a part should be made. The relatively recent adoption of standardized numerical symbolism and terminology for specifying surface finish, for example, has eliminated confusion as to the limits within which a machinist must work. The question can be asked, therefore: Should a standard symbol be adopted for industry-wide use to designate on engineering drawings the allowable out-of-roundness of the part?

Based on a recent article appearing in the *General Motors Engineering Journal*, by permission of the General Motors Corporation.

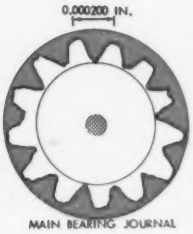
Fig. 5. This precision spindle instrument can detect roundness deviations of less than 2 millionths of an inch on parts up to 18 inches in diameter. A lapped spindle is held concentrically and axially by hydrostatic bearings located in a housing (A).

The procedure used for measuring roundness is as follows: The part to be measured (B) is placed on an adjustable table (C). The part is adjusted to be approximately coaxial with the spindle by means of coarse adjusting controls (D). A stylus (E) is then engaged with the part by appropriately adjusting a stylus carriage (F). Radial motion of the stylus is indicated on the meter (G). Further manipulation of controls (D) and (F) is made to align the part with the spindle to an accuracy of about 0.001 inch.

Fine centering up to millionths of an inch is done by turning micrometer adjusting screws (H) which displace the housing (A) through a 25-to-1 lever system using frictionless spring pivots. Fine compensating adjustments to center the needle on meter (G) for the stylus radial position are made at (J). After adjustments have been made for minimum meter variation, a circular paper is placed on platen (K). A flexible drive-shaft (L) is then lowered into position and the drive motor is activated by switch (M). A recording pen is then engaged for one revolution of the spindle assembly. The resulting chart, a Roundigram, is a circular recording of the radial variations of the part from a perfect round. If closer inspection of surface finish is desired, a strip chart having greater circumferential magnification may be made on recorder (N).



Circular charts (Roundigrams) produced by the GM Roundicator, a precision spindle instrument used to measure out-of-roundness of machined parts



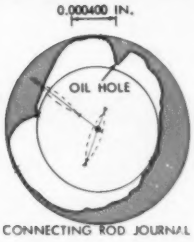
MAIN BEARING JOURNAL

Circular chart showing two distinct types of protuberances that contribute to out-of-roundness—the two per revolution, which some investigators refer to as ovality, and the thirteen per revolution, which some might refer to as waviness. The type having thirteen protuberances per revolution is impossible to detect by measuring the diameter, yet is far more serious in reducing the load-carrying capacity of a journal bearing for equal out-of-roundness contribution than the two-protuberance pattern.

These two charts show traces produced from parts which have been centerless-ground. The chart at the top is an example of the work produced by a centerless grinder that has not been adjusted to remove the uniform lobing characteristics of many machined parts. The out-of-roundness is quite small in terms of conventional shop practice, being on the order of 0.000080 inch. In the chart at the bottom, the characteristic of the surface is quite random, which is typical of parts produced by a centerless grinder that has been adjusted to remove the uniform lobing property.

DIESEL ENGINE FUEL INJECTOR PLUNGER

This illustrates how a chart might be used to study the leakage area of an out-of-round piston fitted into a round hole. The shaded area represents the leakage path. The out-of-roundness of this part is only 6 micro-inches.



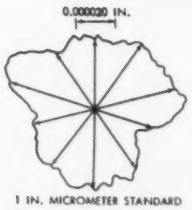
CONNECTING ROD JOURNAL

The construction required to locate the center of an irregularly shaped object. Out-of-roundness is the difference between the radii of inscribed and circumscribed circles.

Of all the charts shown only this one is of a part where the out-of-roundness could be checked by making multiple measurements of the diameter. Ovality is typical of thin-walled cylinders.

MAIN BEARING JOURNAL

A record of a journal bearing that includes an oil-pressure supply hole is illustrated here. Since the out-of-roundness of only the journal surface is of interest, the effects of the oil hole are ignored.



1 IN. MICROMETER STANDARD

1 IN. MICROMETER STANDARD

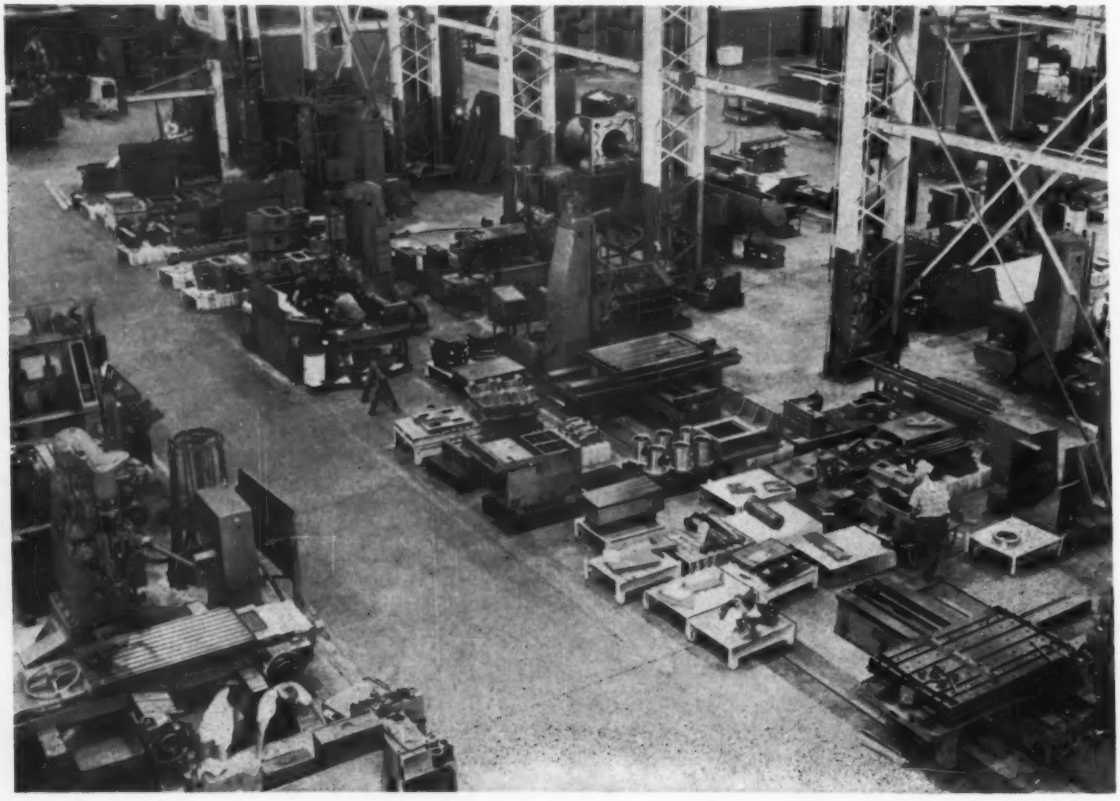
The chart at the top is an example of a trace made at a very high magnification from indicator to recorder. The differences in diameter can be determined by measuring the difference in the length of arrows which pass through the center of the recording. The diameter of this part, which is a micrometer testing gage, is constant within 6 parts in 10^6. The chart at the bottom shows that the out-of-roundness is considerably higher, being on the order of 40 parts in 10^6 when referred to the radius of the gage. This particular trace is not centered with respect to the chart, but the error introduced in the radial measurements by not centering perfectly is small, being less than 1 micro-inch.

Opening of New Facilities Marks Sixtieth Anniversary

THE National Automatic Tool Co., Inc., has opened its new and ultramodern home in Richmond, Ind., in commemoration of the sixtieth anniversary of the founding of the company. Situated on a 140-acre site, the new plant has a manufacturing area of more than 360,000 square feet, in addition to an office area of about 40,000 square feet.

A variety of new products were displayed for manufacturing executives from metalworking or-

Critical boring operations on various machine tool elements are carried on in this huge bay. It is one of several measuring approximately 500 feet long by 75 feet wide.



ganizations throughout the country during a recent "open house." Shown for the first time was the new line of Natco-Delapena induction heat-treating equipment being offered through a cross-licensing agreement with Delapena & Son, Ltd., of Cheltenham, England. During a demonstration, gear teeth were case-hardened under water, then the involutes were checked to show that minimum distortion had occurred.

Also on display was the new Natco single-spindle numerically controlled machine complete with an automatic tool changer capable of handling thirty-two tools. It provides fast tool change of random selection without the coding of individual tools.

A second numerically controlled machine was displayed—this one having two spindles. It is offered through a cross-licensing agreement with Ateliers G.S.P., of Courbevoire, France. An individual automatic tool changer services each spindle. One spindle is of heavy design for milling, boring, or other operations requiring extreme rigidity and has a changer accommodating eighteen tools. The second spindle is for high-speed drilling, reaming, and tapping. Up to thirty-six tools can be accommodated by this changer. Table and head positioning is determined from measuring bars arranged with built-in temperature-compensating devices, and is completely separated from the actuating mechanisms for the three axes of movement.

To be seen in production operation were vertical Natco/Jes-Cal honing machines of both the hydraulic- and mechanical-feed types. Tolerances were consistently held within 0.0003 inch on size, taper, and roundness. Advantages of their plug size control were emphasized.

Supplementing this line were Natco-Delapena vertical and horizontal honing machines. They are built primarily for finishing long bores of above-average diameters. The vertical model will handle bores ranging from 2 to 8 inches in diameter and up to 5 feet in length. Horizontal machines will handle the same range of bore diameters, but in work up to 10 feet in length.

Exhibited also was the company's new line of basic building-block units of both mechanical- and hydraulic-feed types. Sizes ranged from 3/4 hp up to 30 hp, or—by building-block standards—from No. 1 size to No. 5 size, inclusive.

The production of one-piece forged spars for today's airframes is facilitated by automatic die-sinking on this large Keller machine. It is one of several employed in the extensive Wyman-Gordon operated United States Air Force plant at North Grafton, Mass. The steel die shown is for forming aluminum aircraft spars 11 feet 10 inches long in the world's largest closed-die forging press (capacity—50,000 tons).

Precision Bearing Technology Takes a Giant Step

(Continued from page 87)

raceway itself is checked so that inner and outer rings can be matched with proper ball size.

After the bearing has been assembled and matched (inner and outer rings, ball retainer and balls) it is disassembled, ultrasonically cleaned in three different solutions, then visually inspected once again. This is to be sure there are no flats, dents, pits, or anything else that will disturb the smooth rolling of the balls.

Special treatment is accorded the oil-impregnated phenolic ball retainers used in 20-millionths bearings because they serve not only as ball separators but as lubricant sources. The initial charge of lubricant they carry is only a few milligrams of oil, but this must suffice for thousands of hours of service since it is impossible to relubricate the bearings once they are installed in a component that is sealed in a guidance mechanism.

Standard boring and deburring procedures are used for early manufacturing stages of the retainers, but to tolerances considerably finer than those for standard superprecision bearings. Following dimensional gaging they are examined and further deburred under microscopes. Then they are checked to see that oil absorption and bleedout characteristics are within the limits imposed.

Bearing Parts Must Be Carefully Matched

Matching of the rings and balls is an important phase of bearing assembly. And the key to correct matching is the contact angle. This angle is being measured in an assembled bearing with the gage shown in the heading illustration.

An axial thrust load of 5 pounds is applied to the bearing during the check, causing the balls to shift from the center of the raceway. The angle formed between the contact point of the balls and raceway and the plane through the ball centers is called the contact angle. In the 20-millionths bearings this contact angle is assembled to 33 degrees, plus or minus 1/2 degree.

A nomograph is consulted when the bearing is assembled. Knowing the diameter of the raceway in both rings, a suggested ball size is noted. To check this, the assembled bearing is placed in the gage as illustrated, and a weight is added to provide the 5-pound thrust load. A pointer arrangement, shown in the operator's hand, rides on the ball retainer.

Contact angle is checked indirectly, rather than directly. The gage rotates the inner ring (outer ring is fixed) a total of thirty revolutions. As this happens, the balls also rotate, carrying the retainer with them (and also the pointer), but at a slower speed than the inner ring. The ratio of the number of revolutions of the inner ring to the number of revolutions of the retainer is a direct function of the contact angle. The higher the contact angle the shorter the path the balls trace.

If the angle proves to be out of limits, the bearing is disassembled and an adjustment is made in the ball size. All balls are of the same nominal diameter, 0.0937 inch, but are sorted into approximately fifty size groups above and below this figure in increments of about 0.00030 inch. Because of the close geometry control exercised over the bearing parts they seldom must be reassembled more than once to achieve the correct contact angle.

In another step the inner-ring offset is checked. This is a standard measurement that is determined by placing a 10-pound thrust load on the bearing and noting the amount one face protrudes beyond the other. Such information is essential when the spacer is ground to establish the required 10-pound preload on both bearings when secured in place at either end of a shaft.

A final operation before packaging measures the slow-speed torque of the bearing (also a measure of race and ball quality). The bearing is nested in a rotating housing of a company-developed torque dynamometer. A shaft passes through the bore and is attached to a bellows. By operating a bellcrank, a thrust load can be applied to the bearing through the bellows. With the outer ring rotating at a speed of 1 rpm and a thrust load of 10 pounds being exerted against the inner ring, the torque can be read directly on an indicator (a wire, fixture, lever arm, and strain gage linking the bearing to the indicator).

All white-room checks on the inner ring, outer ring, and assembled bearing that have been recorded provide written evidence of size and geometry. One complete set of these documents, or pedigree, travels with each bearing into the field, while a second set remains on file at Barden. (A typical final inspection sheet can be seen in Fig. 13.) Even the plastic trays used to hold the rings and balls for individual bearings are serialized to correspond with the serial numbers marked on the ring faces.

MACHINERY'S Reference Section

For the Designer:

How to Delineate Screw Threads

Part II. Representing the Thread and Denoting Functional Features

ROBERT V. Mac KENZIE
Development Engineer
Cone Automatic Machine Co.
Windsor, Vt.

NOVEMBER 1961

For the Designer

How to Delineate Screw Threads

Part II. Representing the Thread and Denoting Functional Features

ROBERT V. Mac KENZIE
Development Engineer
Cone Automatic Machine Co.
Windsor, Vt.

THE MANNER in which the screw thread is shown on the drawing depends not so much on hard and fast rules as it does on the idea that is desired to be conveyed. There are standard practices established and rules to follow, but it is well to remember that the fundamental information is contained in the designation and specification. Therefore, the delineation of the screw should be simple and coincide with the description.

Pictorial representations like those in Fig. 7 are pretty but time-consuming and actually add little to a detail drawing. This style has a place on some types of design drawings and is also quite useful in highly illustrative work. Because the degree of refinement will depend upon the designer or the particular requirements, no attempt will be made to discuss this technique. For the general run of detail and assembly drawings it is advisable to avoid the pictorial approach. Such practice may tend to confuse, especially if the part is complex or has many threads. Simplicity and clarity are the essentials for which to strive.

Standard Methods of Thread Representation

There are three accepted standard methods of representing threads on a drawing. They are the simplified, the regular, and the semiconventional methods. Each method has definite advantages. The draftsman must choose which method to use to best fulfill the requirements of the particular drawing to be made.

1. Simplified Method. This is recommended wherever it can be used without jeopardizing the interpretation. About the only exception would be when showing exterior or sectional views of assembled parts. In these instances, the regular or semiconventional methods are preferred. As shown in Fig. 8, the thread proper is indicated by lines made of short dashes. These lines are drawn parallel to the axis at approximately the thread depth. The thread is drawn the same in both sectional and elevational views. Simplified symbols are used as shown—unless, of course, the thread

A clear and complete representation of all the pertinent features of screw threads by the designer will do much to eliminate costly misinterpretation of production drawings in the shop. Here is the second of a two-part comprehensive review of what a designer should know in order to adequately delineate screw threads. The information presented is fundamental and practical, and covers the many types of threads in use today. This series is based on a chapter of the author's new book entitled Screw *Threads—Design, Selection and Specification

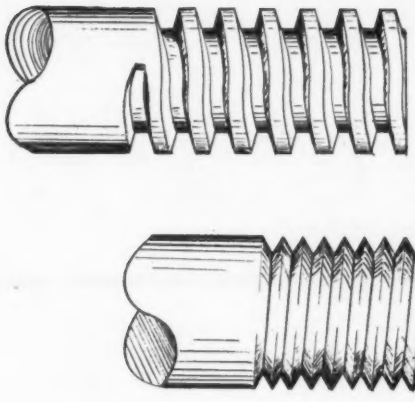


Fig. 7. Pictorial representations such as these add little to a detail drawing.

is special and requires a more detailed description.

A chamfer should be shown on the end of part. This can be drawn as in Fig. 8 and dimensioned in the regular manner. The chamfer serves in a number of ways. It helps the threading tool get started in some cases. It eliminates the sharp feather edge produced by the partial thread and also aids in engaging the mating part at assembly. In Fig. 8 dimension *L* would normally indicate the amount of full thread required. This is shown in greater detail in Fig. 20.

Any recess or relief where the thread runs out should also be indicated (Fig. 8). This will remove any doubt that might exist regarding the length of full thread. The machine operator should not have to guess about this dimension.

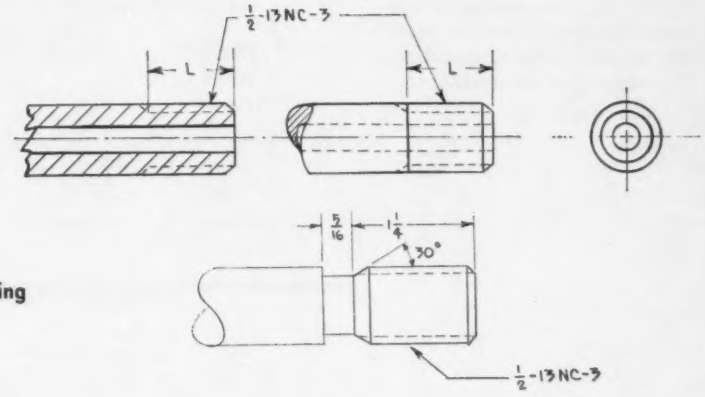


Fig. 8. Simplified method of drawing external threads.

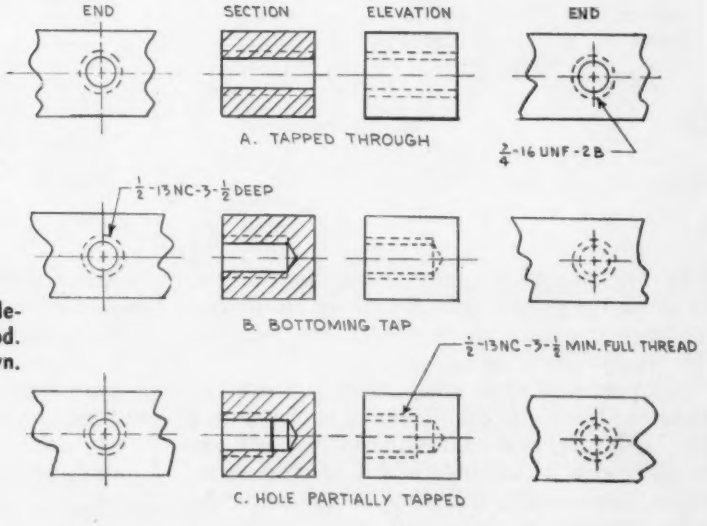


Fig. 9. These internal threads are delineated by the simplified method. Three types of tapped holes are shown.

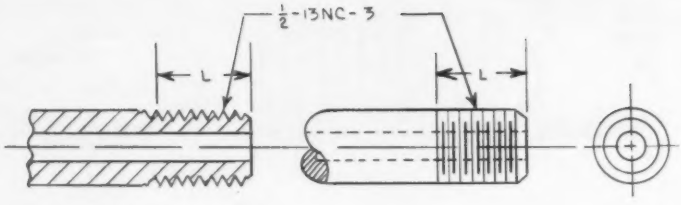


Fig. 10. External threads drawn by the regular method.

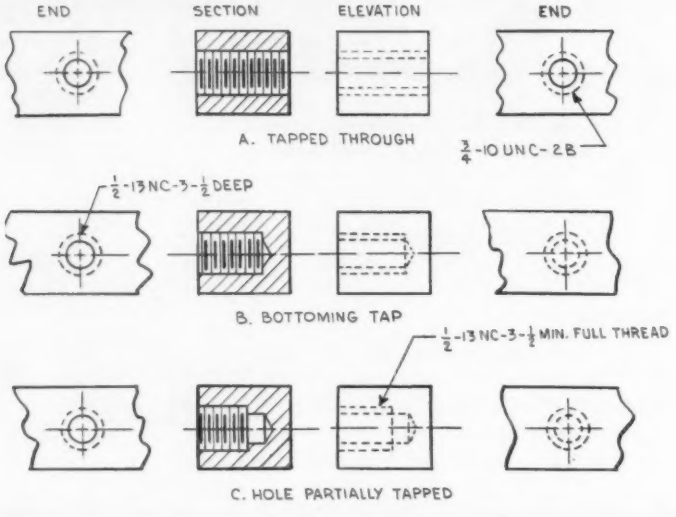


Fig. 11. Regular method of representing internal threads. Methods of indicating tapped holes are again illustrated.

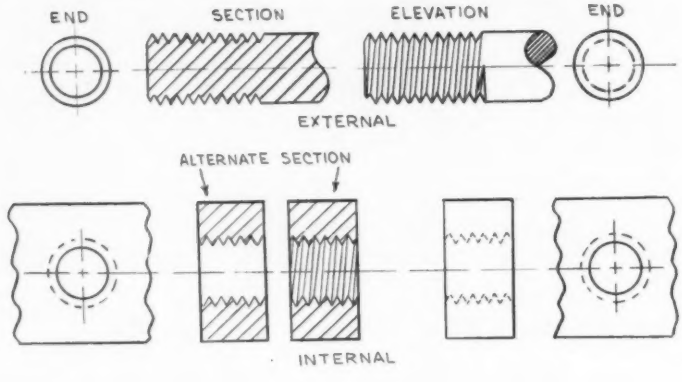


Fig. 12. In the semiconventional method, the thread profile is drawn in all except the end views.

Most threading tools require some room for runout or for the partial threads making up the cutting edge. If space is short, the amount of permissible runout should be shown.

The actual effective relief starts at the minor diameter. It should be dimensioned from that point or below, as shown. Only in this way can the real value of the length of recess be determined. To dimension it starting at a point on the major diameter is misleading inasmuch as the dimension given will always be greater than the actual amount.

Treatment of internal threads, Fig. 9, is essentially the same as for the external. Lines made up of short dashes indicate the thread, in both section and elevation. As illustrated in Views B and C, when the tap-drill hole is not a through hole, it is indicated by a line at the minor diameter of the thread. In section this is a solid line. In elevation it is made up of short dashes. The drill point

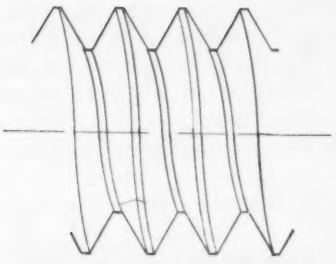


Fig. 13. The true projection of a helical thread, shown here, is pleasing to the eye but seldom used on design drawings.

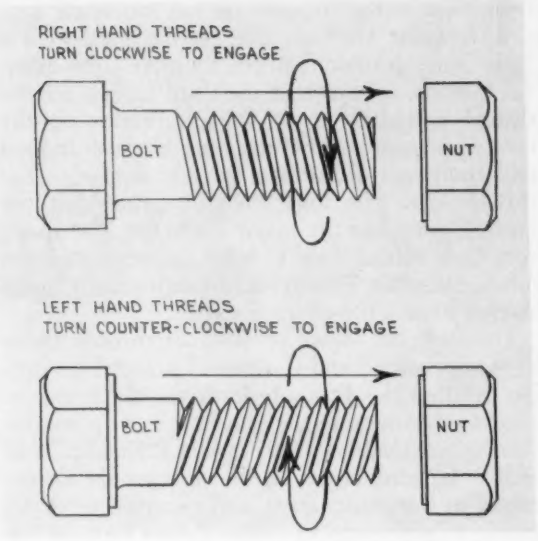


Fig. 14. Top and bottom profiles are connected by straight lines slanted to represent either a left- or a right-hand helix, according to the direction of the thread required.

is shown as lines drawn at 60 degrees to, and meeting at, the center line.

When a bottoming tap is used, the depth of drill and depth of thread can be shown in the same manner. The required length of thread should be included in the designation. When a bottoming tap is not required, or the depth of tap drill is not critical, the thread can be shown as in View C. Here again, however, the length of thread desired should be specified. The term "Min. Full Thread" is preferred in all cases. Even a bottoming tap has some chamfer, and specifying the tap depth as Min. Full Thread will insure that the thread plug gage will enter to this depth,

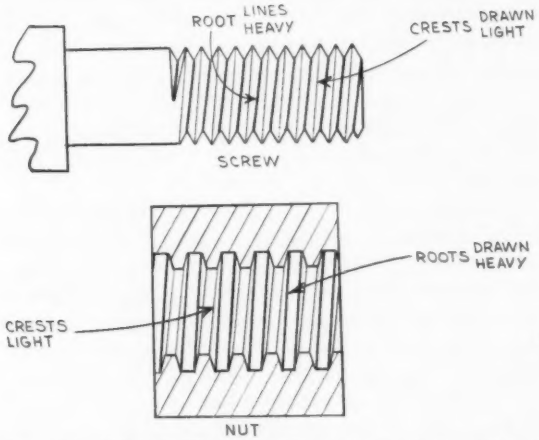


Fig. 15. (Above) Threads drawn in semiconventional style, with crest and root lines varied in weight for depth effect.

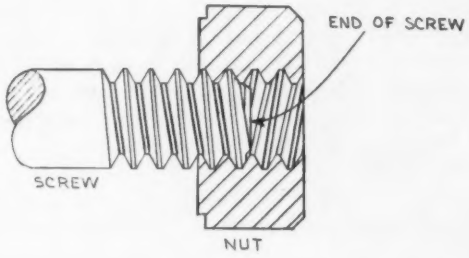


Fig. 16. (Above, right) Here a semiconventional nut and screw assembly drawing shows the value of weighting crest and root lines.

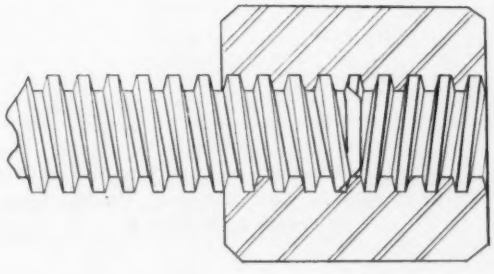


Fig. 17. (Right) Semiconventional method is recommended for drawings of translating thread assemblies such as this Acme screw and nut.

regardless of the chamfer on the threading tool.

2. Regular Method. The regular method is a little more graphic than the simplified. On external threads, as shown at the right in Fig. 10, the thread is indicated by lines representing the crests and roots. These lines are alternately long and short and are drawn at right angles to the thread axis. The long lines (representing the crests) extend to the major diameter. The short, root lines extend only to what approximates the minor diameter. These root lines are usually made thicker to give the effect of depth.

On sectional views of external threads these lines are omitted and the thread is shown in profile. Neither the alternate lines nor the profile is necessarily drawn to the exact pitch. Any reasonable approximation (Fig. 10) is sufficient. It is well to be sure, however, that the profile corresponds to the designation and description. A V-profile to represent an Acme thread form is not only a waste of time but can be misleading.

Internal threads are drawn as shown in Fig. 11. The sectional view is identical with the external elevation shown in Fig. 10. The alternate long and short lines are drawn at the approximate pitch to represent the crests and roots.

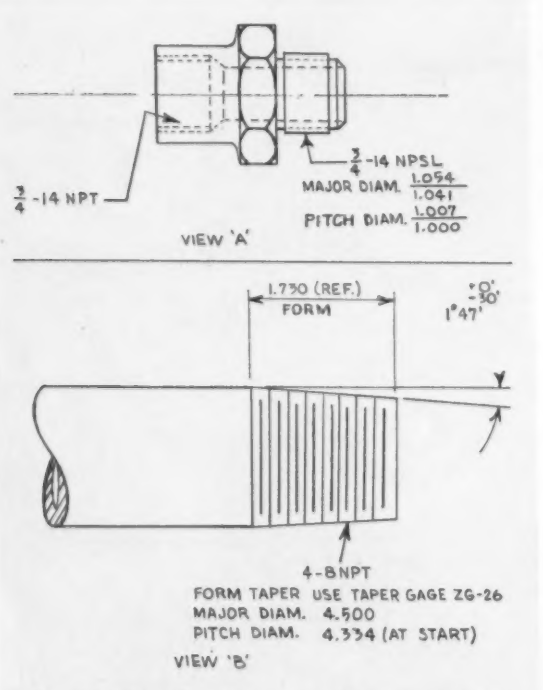


Fig. 18. Pipe threads are usually represented as shown in View A. When necessary, the taper may be drawn as in View B.

In the section view, when the hole is not a through hole, it is indicated by solid lines and the point or end is shown by lines drawn 60 degrees to the center line. When a bottoming tap is to be used, only the drill-hole point is shown as in Fig. 11, View B. Here again it is well to always specify the depth of thread by the words Min. Full Thread. This is preferable to the word "deep," given in View B. End views and elevations are drawn the same in both the simplified and the regular methods.

3. Semiconventional Method. This is a refinement of the first two methods discussed. Tending toward the pictorial approach, this method has value in picturing complex threaded assemblies. It is used quite often on Acme and other threads having similar forms.

As illustrated in Fig. 12, the thread profile is drawn in all views except, of course, the end view. The helices are shown on external elevations and optionally on sectional views of internal threads. Instead of the true helical curve seen in Fig. 13, slanting straight lines are used to link the top and bottom profiles. These lines should be made to slant correctly, to coincide with the designation of Right or Left Hand (Fig. 14).

The sharp V-profile is permissible for all National Form threads except when drawn in enlarged detailed views. In these cases the crests and roots should be shown in approximately the proper scale. Threads other than National Form are drawn in their actual profile.

The effect of depth is obtained by varying the line weight, Fig. 15. Profile and the root helices are heavy lines. Crests are drawn with fine lines. When an internal thread is shown in section, the weight of the lines is similar. The root helices are drawn heavy, since they are in shadow, and the crests are shown light.

The value of weighting the crest and root lines is best illustrated by the screw and nut assembly seen in Fig. 16. Here the nut is shown in section and the screw in elevation. The far side of the internal thread is visible. Being farthest away, the roots are shown heavy. Crest lines are drawn light. On the screw, the near side is exposed; therefore the crests are light and the roots heavy. The helices on screw and nut slant in opposite directions, and the whole effect makes the two parts stand out quite distinctly.

4. Miscellaneous Thread Forms—*Translating Threads.* This group includes the Square, Modified Square, Acme, Stub Acme, 60-degree Stub, Worm, and Buttress thread forms. The translating threads are best drawn by either the regular or the semiconventional method. When shown as components on an assembly drawing, the semi-

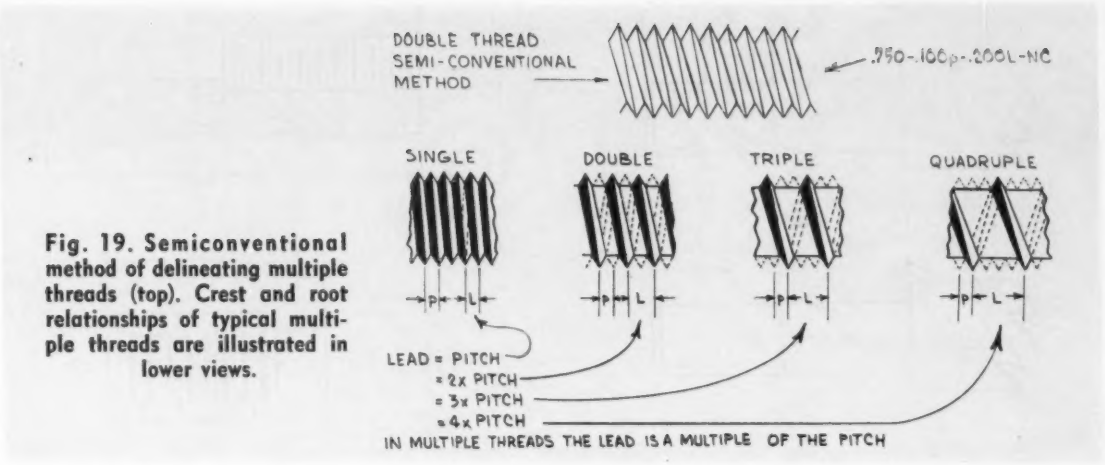


Fig. 19. Semiconventional method of delineating multiple threads (top). Crest and root relationships of typical multiple threads are illustrated in lower views.

conventional method is recommended. Typical of the translating forms is the Acme screw and nut assembly seen in Fig. 17.

Pipe Threads. In most cases, pipe threads are drawn in the same manner as regular screw threads. The various designations will indicate whether the thread is straight or tapered. For this reason, it is not necessary to show the taper on the drawing. Usually, pipe threads are drawn as illustrated in Fig. 18, View A.

When the taper of the part to be threaded is to be preformed or if, for some other reason, it is desired on the drawing, it can be shown as illustrated in Fig. 18, View B. The taper should be emphasized by drawing it twice what it actually is. If the thread diameter is to be preformed to the proper taper, this information usually will appear in conjunction with, but preceding, the thread description.

Multiple Threads. Multiple threads may be shown in the regular or simplified manner. It is recommended, however, that the semiconventional method be employed. Multiple threads are often the cause for confusion; therefore the accent on the helix which the semiconventional portrayal provides can sometimes complement the designation and description.

When the thread is an even multiple (i.e., double, quadruple, etc.), a crest is drawn opposite a crest. If the thread is an odd multiple (triple, quintuple) a crest is drawn opposite a root, similar to a single thread, except for the helix.

In Fig. 19 the semiconventional method is used to show a double or two-start thread. The lower section of the same illustration indicates how the crest and root relationship is derived.

Additional Standard Delineation Practices

In addition to the basic practices just outlined there are other common procedures which can contribute to lucid thread representation. Some are quite fundamental, but for that very reason are often overlooked. Others are more on the order of applying standard drafting procedures to thread design.

Thread Length. Thread length is always shown graphically and dimensioned on the drawing. This length should be specified as Min. Full Thread or Max. Full Thread, whichever the case may be. In this way an allowance will be made (if not shown on the drawing) for any chamfer on the end of the part, and also for tool runout. This latter is important when the thread does not enter a relief or recess (Fig. 20). Whenever conditions permit a recess, its dimensions should be given. This enables the allowable chamfer on the threading tool (Fig. 21) to be quickly ascertained.

Assemblies. Threaded assemblies should be drawn with care. The more complex the assembly, the more discretion should be used in choosing the manner of representing the various threads. The method to be used will depend on many factors. Among these will be type of thread, thread length and length of engagement, and thread location with respect to other part features which might tend to confuse or mislead. Each assembly drawing will be pretty much of a special case, and showing the threads will have to depend upon the requirements and conditions pertaining to that particular case.

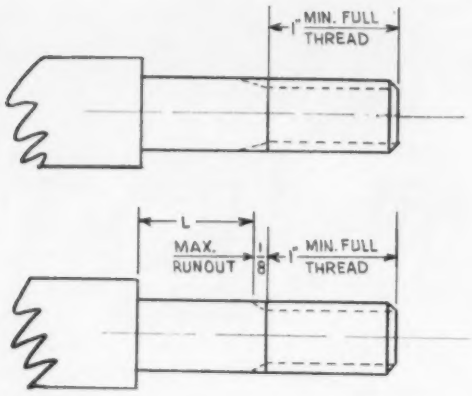


Fig. 20. Minimum (or maximum) length of full thread should be shown graphically and dimensioned on the drawing.

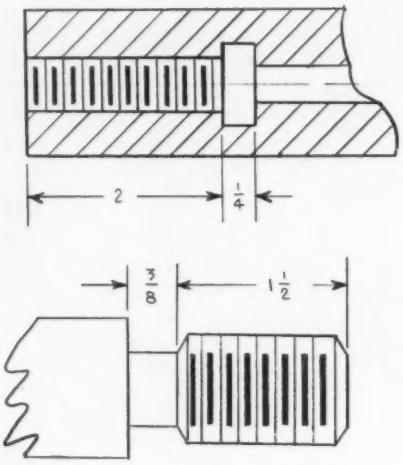


Fig. 21. Recesses for threading should be dimensioned. It will assist in determining allowable tool chamfer.

In general, the use of the simplified symbols is not recommended on assembly drawings. Represented only by straight lines made up of dashes, threads shown in this manner might easily be mistaken for some other feature of an assembly.

The regular method is preferred. On the more complex drawings it is used in combination with the semiconventional. In Fig. 22 a simple assembly is shown drawn in two different ways. One drawing uses simplified technique on the stud bolts and nuts, combined with a semiconventional presentation of the shaft and collar. The other drawing shows both studs and shaft in the regular method. In each of these cases the delineation is adequate and not likely to be misunderstood.

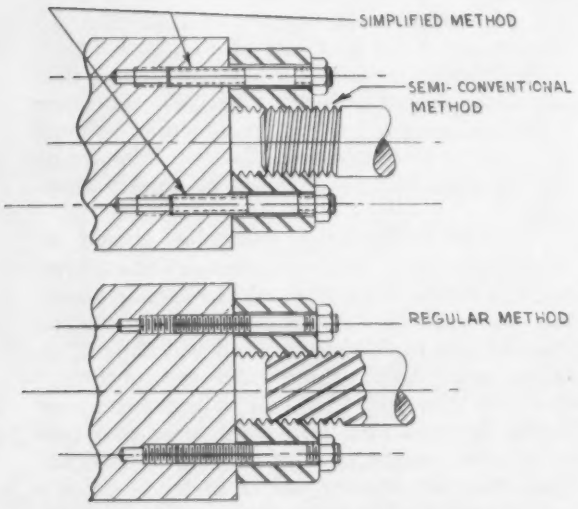


Fig. 22. Although the regular method of thread delineation is preferred on assembly drawings, techniques are often combined where the result is not likely to be misunderstood.

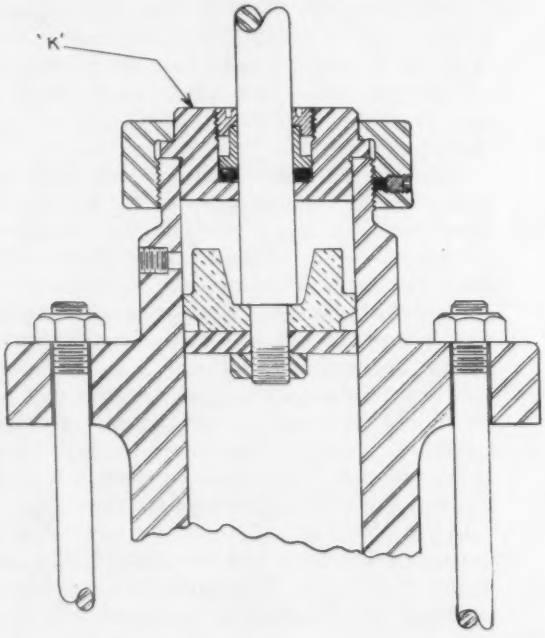


Fig. 23. The regular method is usually clearer, especially for the more complicated assembly drawings.

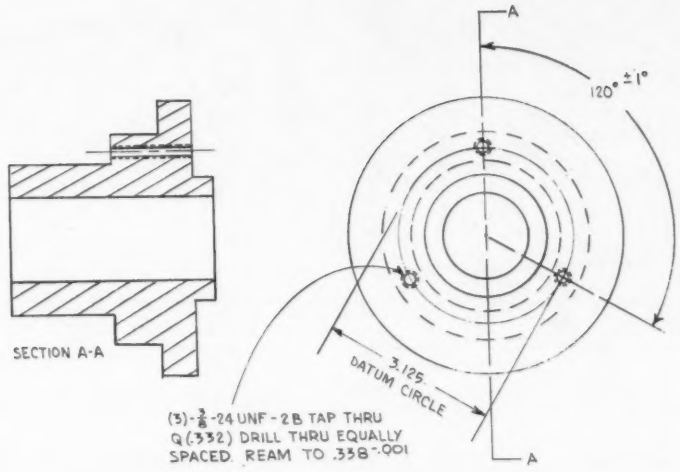


Fig. 24. When the hole requires boring or tapping, both the production method and dimensional tolerances should appear on the drawing.

A somewhat more complicated assembly is shown in Fig. 23. Here the regular method is used throughout. Even though there are a number of threads involved and some of these are in close proximity, the whole presentation is clear and clean.

Minor Diameter of Internal Threads. In the general run of work, the minor diameter of the internal thread is determined by the tap drill. Tap-drill sizes are regulated by the size and pitch of the thread and frequently by the class of fit. The minor diameter is the same for all classes of fit in the American National Thread Series. In the Unified Thread Series the minor diameter varies with the class of fit and length of engagement. To denote the drill size on the drawing is good practice. Tables showing recommended hole sizes for tapping may be found in *Federal Services Handbook H28* (1957) Part 1 (pages 186-193), and also in MACHINERY'S HANDBOOK, Sixteenth Edition (pages 1231-1237).

Under certain conditions it is advisable to ream or otherwise refine the hole, after drilling but before tapping. Some materials may not machine readily and the finish produced may not be acceptable, or the minor diameter may have to be held within close limits. Whenever the hole needs reaming or boring after drilling, the information pertinent to these operations should appear as part of the thread specifications (Fig. 24).

Frequently, where the mating thread is preceded by a pilot, control of the minor diameter is essential. Inclusion of minor-diameter data on the drawing is necessary in such cases—as, for

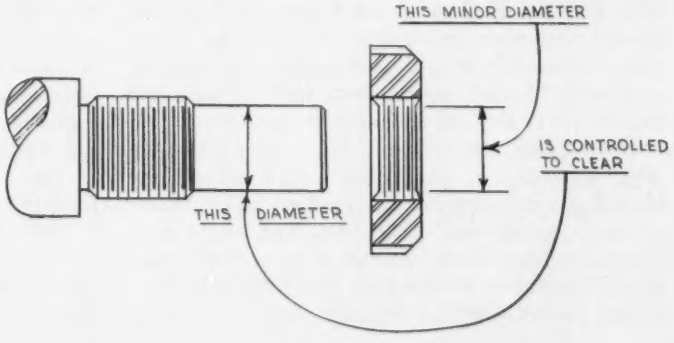


Fig. 25. Indication of the minor diameter is necessary where it must be closely controlled in order to clear a pilot.

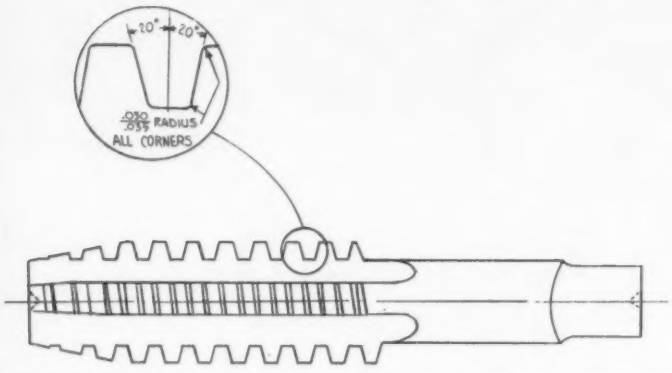


Fig. 26. Enlarged insets are desirable for showing details of special-form threads.

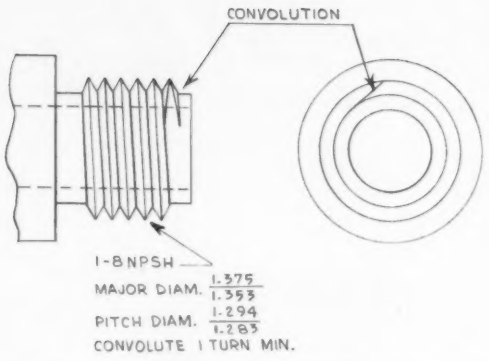


Fig. 27. Convoluting is the accepted method of removing the sharp, incomplete portion at the start of a thread.

example, the bearing lock-nut shown in Fig. 25.

Insets. Vivid highlighting of the critical aspects of a thread is sometimes best done by using insets of the particular features showing the size enlarged two or more times. This technique is especially useful where the thread is on a complicated part and the drawing has become crowded.

Another occasion when insets are desirable is when the thread form is special and a better conception of the details can be conveyed by an enlarged view. A good example of this is illustrated in Fig. 26. The thread form on precision threads such as the one illustrated are customarily shown on a magnified scale. In this way, it is possible to pinpoint each important detail in a manner which would otherwise be difficult.

Convolution. Another name for this is the "Higbee cut" or the blunt start. The term denotes the removal of the sharp partial thread, or feather edge, at the start (Fig. 27). A chamfer reduces this sharp edge to some extent, but on some threaded parts subject to constant handling, convoluting is the accepted method of removing it. The danger of cutting the hands is thereby minimized. In addition, the thread will be easier to start and less likely to cross. Hose couplings and thread ring and plug gages are common examples of cases where convoluting is employed. Occasionally thread-cutting tools and aircraft and missile parts require convoluted threads.

Breaks and Ditto Lines. The time-consuming representation of repetitive detail where the thread is very long can be avoided in a number of ways. Breaks and ditto lines can be used as shown in Fig. 28. Whenever this is done, care should be taken to see that the part is dimensioned properly in the regular way.

Correlating and Denoting the Functional Features of the Thread

The thread on a part can, in itself, be perfect, but this perfection will have little value if the functional aspects of the thread are overlooked. Except in rare cases, the thread bears a definite relation to other features of the part. Usually the requirement is concentricity, squareness, or parallelism to the other feature. This feature may be a shoulder, a face, or a diameter, or it may even be another thread. The usual functional requirements are charted in Fig. 29.

Because of this interrelation, the functional requirements should be considered along with the class of fit. They should, in fact, be established first because many times the tolerance on these will determine the class of fit. It is needless to call for a fit which is not compatible with the squareness or concentricity tolerance because of overlapping or insufficient allowance.

Inherently difficult to obtain and inspect, the functional thread requirements should be kept to a minimum. When essential however, care should be taken to clearly denote and dimension them on the drawing. It is important to denote functional relationships in a manner that will not be misleading. There are a number of accepted ways to show these requirements. Letters, symbols, or notes properly referenced can all be used. Some of the more widely employed methods are illustrated in Fig. 30. The method used should fit the drawing in order to avoid confusion or misinterpretation.

The top View A in Fig. 30 illustrates the use of letter symbols on a simple part. View B incorporates graphic symbols which lend a degree of emphasis to the specification. In View C another

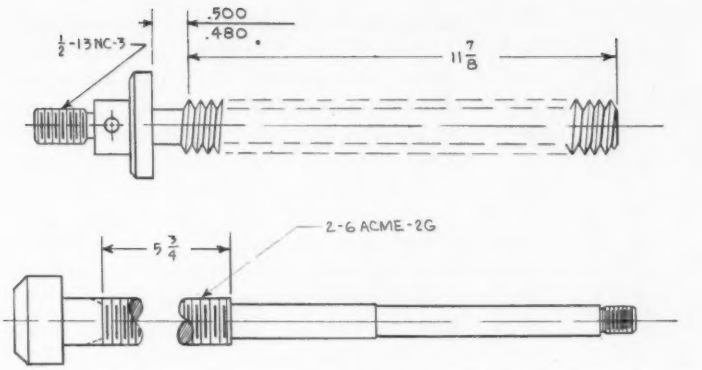


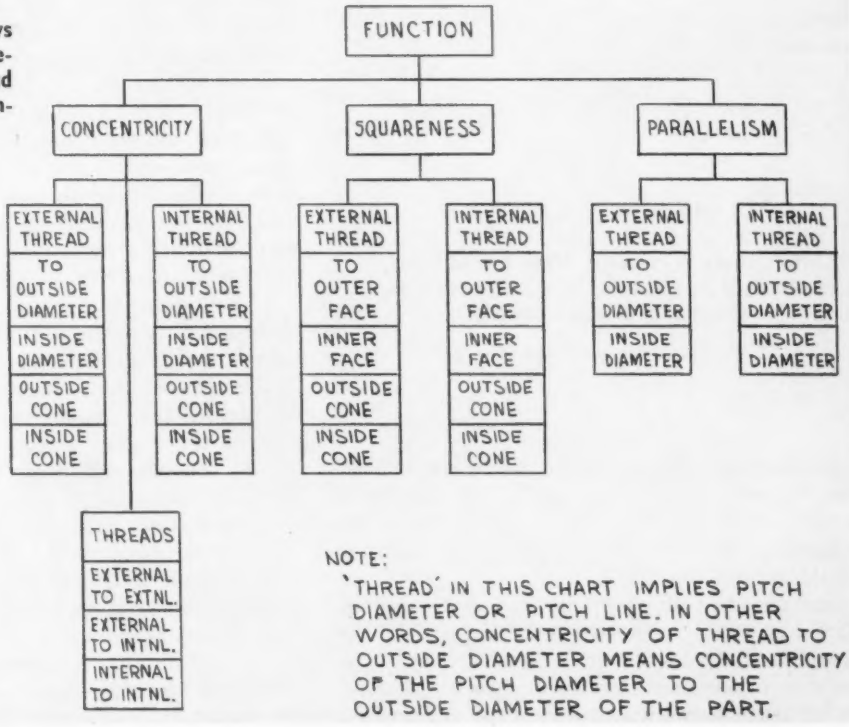
Fig. 28. Breaks and ditto lines help to eliminate time-consuming repetition of details.

way of utilizing letter symbols is shown. This latter method is quite often of advantage on a complex or crowded drawing.

Concentricity. Of the functional qualifications of a thread, concentricity to some feature is the most common. As shown in the chart, Fig. 29, it may be necessary that the pitch diameter of a thread be concentric to one or more of a number of other diameters. The frequency and limits of concentricity will normally vary with the part, but the importance of concentricity can be understood when one visualizes its need in parts for applications such as valves, hydraulic units, couplings, and spindle noses.

It is important, in designating and placing limits on the concentricity of a thread, that the re-

Fig. 29. This chart shows the functional requirements of screw-thread features usually encountered.



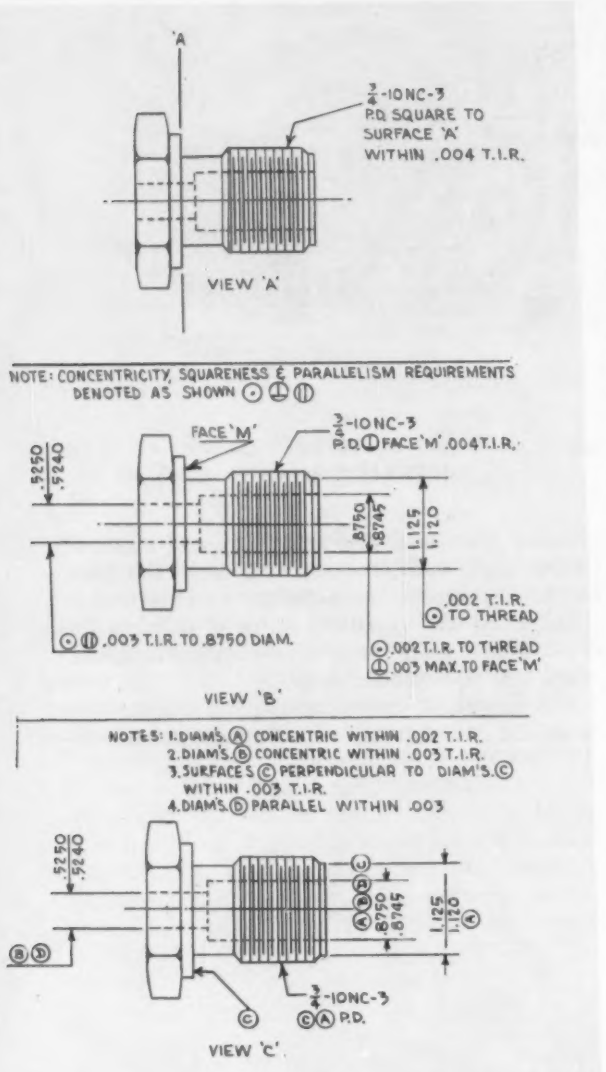


Fig. 30. Letters, View A, symbols, View B, and notes, View C, can be used on a drawing to indicate the functional requirements of screw threads.

quirements refer to the pitch line or pitch diameter. In assembly, this is usually the functional element of the thread; consequently, this is the element to which the concentricity specification should apply (Fig. 31).

One phase of concentricity not shown on the chart, Fig. 29, is that between the elements of the thread itself. In other words, concentricity of the major or minor diameters to the pitch diameter. Under certain conditions this type of concentricity cannot be taken for granted and may have to be checked. Those threading methods where the operator has control over the individual thread elements (for example, grinding) are the ones most likely to need this sort of specification. Most often eccentricity will occur on the major diameter of the external and the minor diameter of the internal thread. The thread ring gage shown in Fig. 32 is an example of a part requiring a tolerance placed on this type of eccentricity. Eccentricity beyond certain limits, between the pitch diameter and the minor diameter, could produce a thread having an undersize effective minor diameter. The narrow flat produced would then be less than the permissible $p/4$ and might cause the rejection of passable parts.

Eccentricity of pitch diameter to major diameter (on external threads) or minor diameter (on internal threads) will also reduce thread depth. This, in turn, will decrease the effective shear section in the mating part and may weaken the thread assembly. Thus it is well to establish and denote on the drawing the eccentricity limits which will prevent this whenever the fastened components are to undergo extreme stresses. Threading tools and gages should also be designed within defined limits of eccentricity.

Squareness. This functional requirement is an important one on a large portion of threaded parts ranging from the common bolt to the highly complex assemblies that are a part of today's hydraulic and pneumatic systems. Many times its importance is overlooked and the requirement fails to appear on the drawing. A major reason for this is the misconception that reduction of the pitch diameter can compensate for out-of-squareness. This is not so, and wherever squareness of the thread to some feature of the part will influence assembly or operation, the requirement should be determined and the limits fixed and specified on the drawing.

The retaining nut shown in Fig. 33 is a typical example. This nut is part of the piston assembly shown in Fig. 23 and serves to fasten bushing *K* to the cylinder body. It can be readily seen that out-of-squareness could result in loss of holding area on the retaining seat, undue stress on part of the threads, vibration, and possible failure. The large diameter of the seating surface makes the requirement more critical.

When the functional face is large, and conditions permit, it is sometimes well to reference the squareness requirement to one or more datum base circles, as shown in Fig. 34. Doing this can clarify and simplify inspection of the part.

The tolerance on squareness should appear on the drawing as a linear indicator reading in

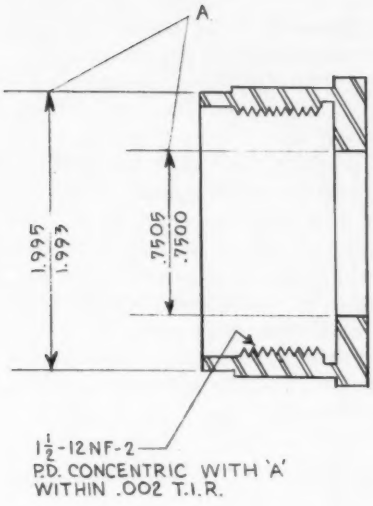


Fig. 31. Concentricity requirements of a thread are denoted in this manner.

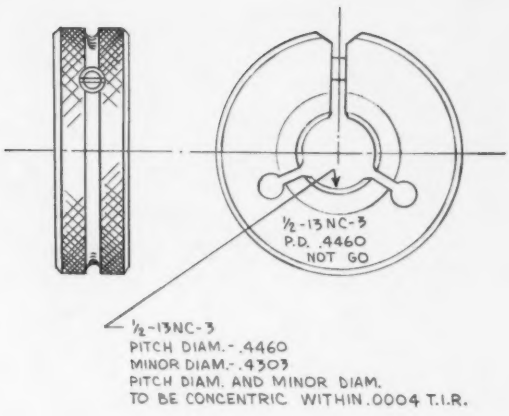


Fig. 32. In this case, a concentricity tolerance is required between two elements of the same thread.

decimals rather than an angular limit in degrees, Fig. 35. Usually the available inspection equipment would give this measurement decimally, thereby necessitating converting the angular tolerance in degrees to decimals.

When the thread must be square to some inner or outer face it usually implies that the face will seat, and perhaps thrust, against some mating surface. This then presupposes that all other functional requirements of this thread will have limits set close enough to preclude encroachment upon the squareness tolerance.

The threaded bushing in Fig. 30, View B, illustrates this condition. Because the part is to seat against face *M* the squareness of this face to the thread is of primary importance. The other functional requirements—in particular, those involving the thread—are established after, and made compatible to, the squareness tolerance. Tolerances set on the mating components must also be evaluated in the light of their interrelation. This interdependence of the functional attributes has may ramifications, and for this reason should be considered only when necessary.

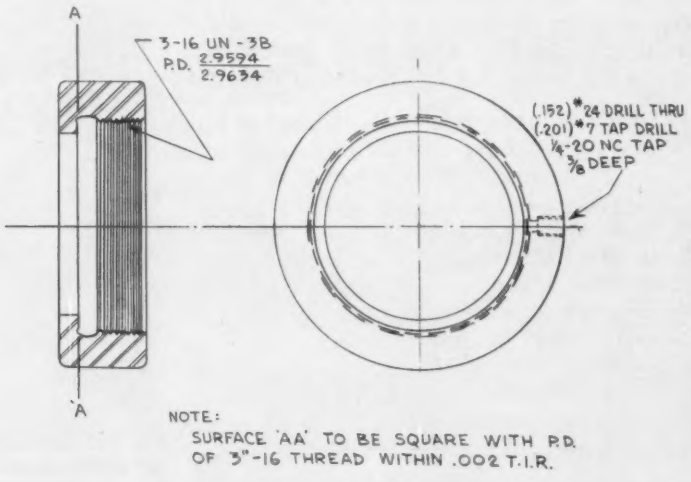


Fig. 33. Here, the tolerance for the squareness of a thread is designated in relation to a machined face.

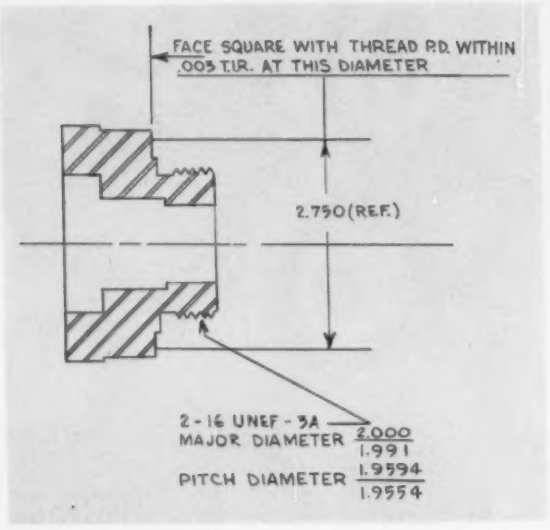

FACE SQUARE WITH THREAD P.D. WITHIN .003 T.I.R. AT THIS DIAMETER
2.750 (REF.)
2-16 UNEF-3A
MAJOR DIAMETER 2.000 / 1.991
PITCH DIAMETER 1.9594 / 1.9554

Fig. 34. In this case, squareness of a thread is referred to a face at a particular size base circle.

When squareness is required between the thread and a conical seat, a problem arises regarding isolating squareness from eccentricity. Usually this cannot be done without an elaborate inspection setup. On some internal conical surfaces it might be impossible. Hence, it becomes doubly important to ascertain first if the squareness and concentricity requirements can be tolerated in combination, and if not, which of the two is the most critical. This may result in saving costly production and inspection time.

Parallelism. Applications which require that a thread be parallel to some surface are not too common. In many cases, establishing squareness or concentricity limits will obviate the need for controlling parallelism. Quite often the concentricity to the thread can be checked at different points progressing along the surface to give, in effect, a measurement of parallelism.

Under certain conditions, however, this method cannot be relied upon. The part shown in Fig. 36 shows why this is true. The requirement here is that a bore be parallel to the pitch diameter of the thread. By rotating part *B* on a threaded arbor and checking concentricity at points 1, 2, 3, and 4, the cylinder wall might be assumed to be parallel to the thread, as is true in the case of part *A*. It can be readily seen that the taper in the bore of part *B* rules out parallelism, even though the concentricity limits are met at any point. Parallelism in this case is an axial rather than a radial relationship.

*Published, 1961, by The Industrial Press, New York City.

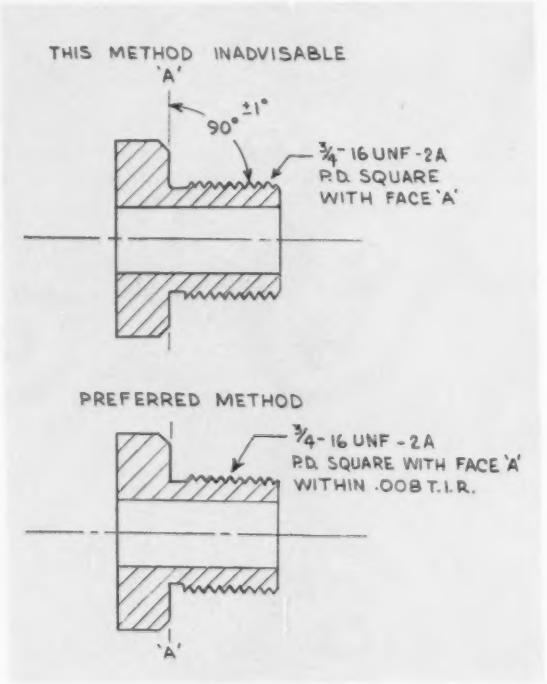


Fig. 35. The tolerance on squareness should appear as a decimal indicator reading, not as an angular limit in degrees.

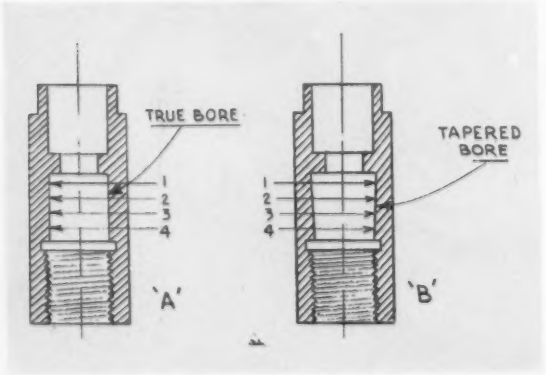
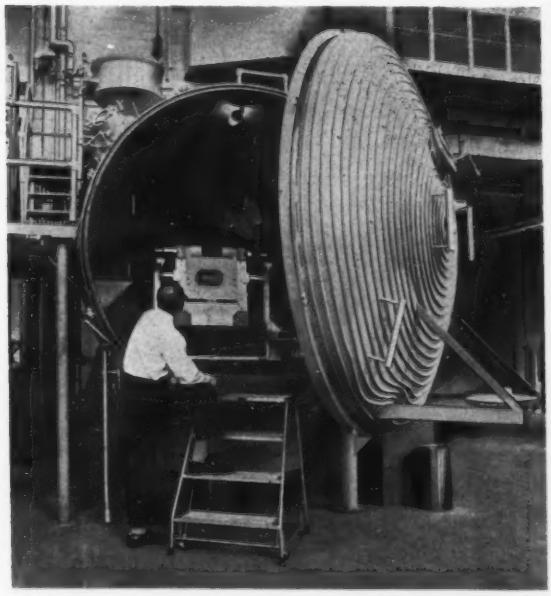


Fig. 36. Checking concentricity at several points does not always insure parallelism of a thread to a bore. The bore may be tapered.

Bethlehem Steel Dedicates Homer Research Laboratories

THE continuing pursuit of knowledge in making better steel is the main objective of Bethlehem Steel Co.'s new research laboratories, dedicated October 9. The new facility at Bethlehem, Pa., named for Arthur B. Homer, chairman and chief executive officer, consolidates in one location the research activities which were formerly scattered in many locations throughout the company. The new laboratory, actually a quadrangle of buildings in campus-like surroundings, will comprise the following separate structures: administration and bench laboratory, shops and warehouses, process metallurgy, electromechanical engineering, mechanical engineering, and photomicrography and public relations.

Since Bethlehem produces an unusually wide range of steel products, the activities of these laboratories will cover many technological fields, including process metallurgy, chemical engineering, physical metallurgy, mechanical engineering, ceramics, physics, corrosion engineering, chemistry, mineralogy, electronics, mechanics, thermodynamics, and nuclear studies.



This large vacuum melting furnace used during research is designed to produce cleaner, higher-quality steels.

Chairman Arthur B. Homer of Bethlehem Steel Co. photographed during a recent visit to the new laboratory which bears his name.

Research here will involve not only bench-scale work in laboratories, but also pilot line manufacturing.

To keep pace with the ever-increasing demands of the space age, and to meet the growing threats of foreign steel competition and competition from other domestic materials, researchers at the new laboratories will direct their efforts toward two basic goals: improvement of existing products and processes, and development of new products and processes.

Research is not a new venture for Bethlehem. While it may be said that research activity, on an informal basis, began with the start of operations and founding of the company, a formal program began in 1926 with the establishment of a development and research department.

Two important early accomplishments prior to 1926 were the development of high-speed tool steel at Bethlehem by Frederick J. Taylor around the turn of the century, and the improvement and development of the wide-flange beam produced on mills invented by Henry Grey and placed in commercial production in 1908. High-speed tool steel was an important factor in bringing in the age of mechanization; the wide-flange structural steel beam helped to make possible today's towering skyscrapers.

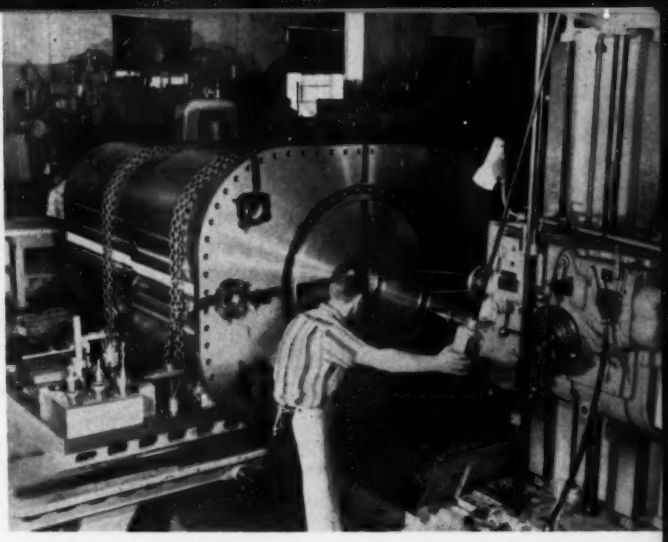
Camera highlights of some interesting operations performed in various metalworking plants throughout the nation

TURBINE RUNNER—Ninety-five-ton hydraulic turbine runner for the Oahe Reservoir Project in South Dakota is being rough-machined at Allis-Chalmers West Allis (Wis.) Works on a 30-foot Niles vertical boring mill. The runner was fabricated by welding crown, buckets, and band into one unit. It was stress-relieved after welding, prior to machining, to help maintain dimensional tolerances.

In Shops Around the Country

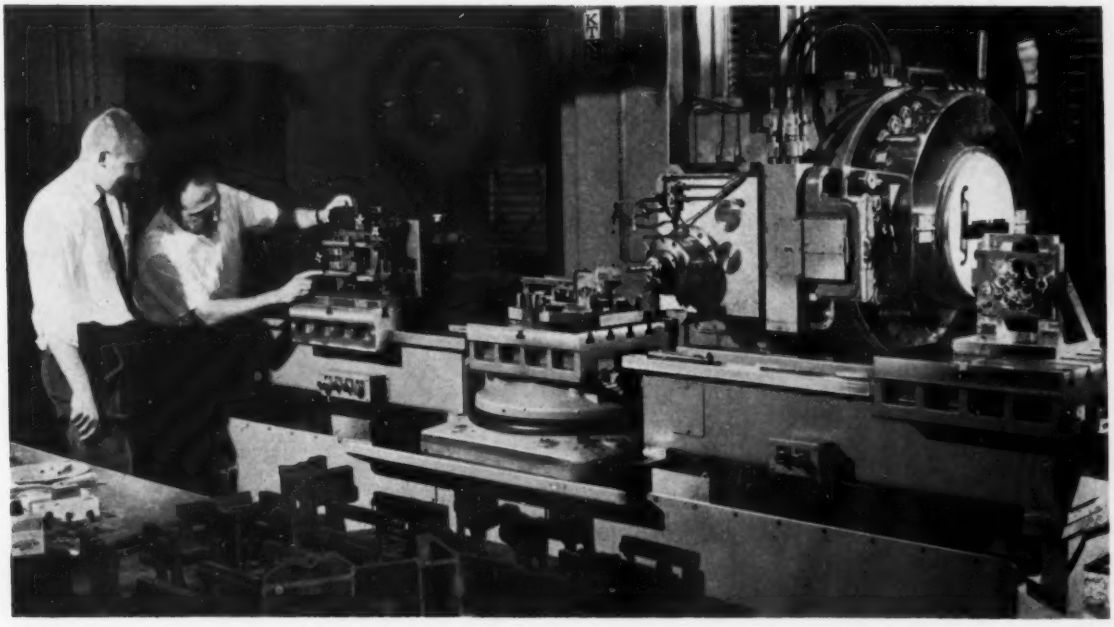
REDESIGNING PAYOFF—Fast, cost-reducing setup developed by the De Vlieg Machine Co., Royal Oak, Mich., is used in the machining of preformed aluminum control turrets now employed in the entire line of the company's precision horizontal boring machines. Turning of the extruded drum as a boring operation is a thirteen-minute job, as compared with a four-to-five-hour lathe operation when steel tubing was used.

TAPPING PROBLEM—Stainless-steel weldment weighing 5500 pounds presented a tapping problem to Magna-Mill Products of South Gate, Calif. Ninety blind holes were needed in depths up to 1 3/4 inches and in sizes from 1/2-13 UNC-3B to 1-8 UNC-3B. At first, hand tapping was performed to avoid excessive tap breakage and imperfect threads. Now, tool life has been increased and production costs decreased by machine tapping, using a Tapmatic "800" attachment.



LIGHTWEIGHT WELDING—(Left) Steam condenser tubes are welded to tube sheets at the nuclear electric generating station of Consolidated Edison Co. of New York at Indian Point. A small pilot of the Revere automatic welding gun centers the gun. The weld is made by a tungsten electrode rotating in an inert-gas atmosphere.

MULTIPLE MACHINING—(Below) Business machine part undergoes multiple machining while another is loaded in fixture at left in shop of Numeric Machining, Inc., Minneapolis, Minn. Aircraft component on pallet at right is handled in sequence on this Milwaukee-Matic.

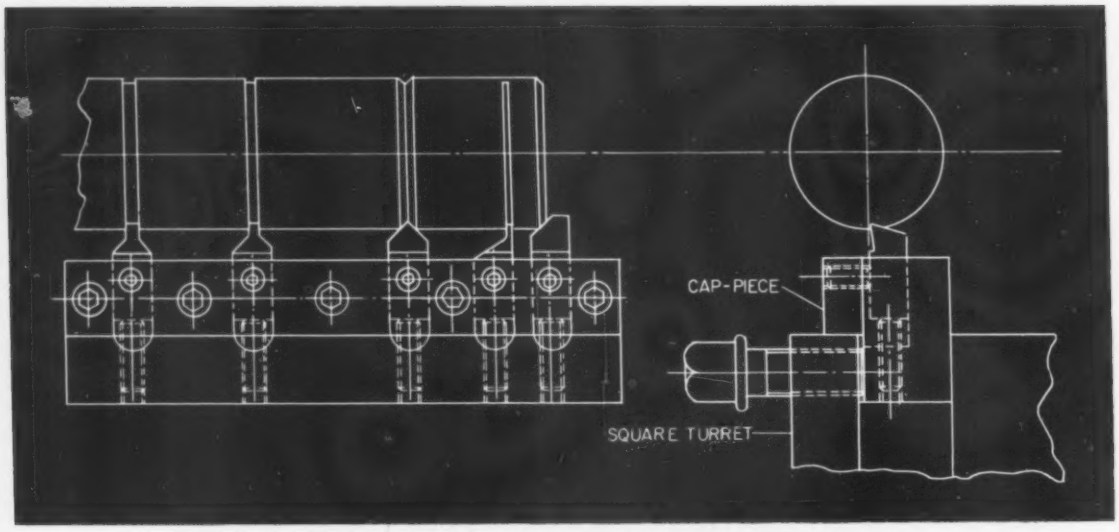


Tool Engineering IDEAS

Tools and fixtures of unusual design and time- and labor-saving methods that have been found useful by men engaged in tool design and shop work

Multiple Holder for Necking and Chamfering Cuts

ROGER ISETTS, Kenosha, Wis.



For repeat jobs, the multiple holder speeds set-up time by retaining the individual adjustments of the tools.

Tools for different necking or chamfering operations performed on a lathe can be grouped in a special multiple holder in one face of a square turret, assuming the cuts to be taken are concentrated in a relatively short span. With the tools operating simultaneously and the indexing of the turret eliminated, much time is saved.

The holder, made from a rectangular section of steel, is end-milled to receive the individual tools. Holes are tapped behind each tool for set-screws which serve to back up the tool and provide a means for its adjustment. A steel cap-piece is secured to the main body of the holder. The cap-piece is also tapped for set-screws which act as tool hold-downs.

Since the unit is self-contained, it can be stored as is. This saves considerable setup time on jobs that are run intermittently.

Lathe Tracer Attachment Turns Quill Taper and Grooves

DONALD A. BAKER, Boonton, N. J.

The textile industry purchases aluminum quills, Fig. 1, for various yarn-winding purposes. To simplify the contour-turning of this tapered and grooved part, a tracer and box tool attachment, Fig. 2, was substituted for the regular cross-slide on the carriage. With this device, the quills are contour-turned in one pass from a template. By changing the templates, the number of grooves, or the length, may be varied.

The lathe is a standard economy-model ma-

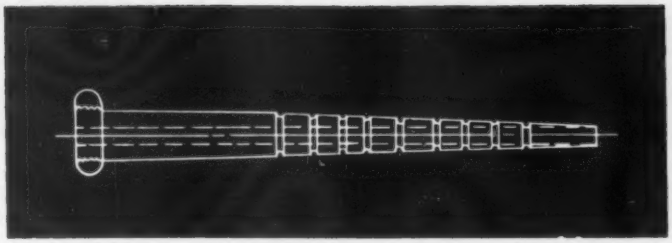


Fig. 1. Aluminum quill is tapered and has nine grooves, all generated in one pass of the tracer tool.

chine, but it has a 1-hp motor to turn the spindle at about 5000 rpm. To drive the parts, a special knurled center was used in the headstock of the lathe and a ball-bearing live center in the tailstock. By pressing the tube firmly over the knurled portion of the headstock center *Q*, no trouble was encountered in driving the work.

The fixture, Fig. 2, consists of a casting *A* fitted to the regular carriage cross-slide dovetail ways. Block *B* is bolted in place, and it carries adjustable steadyrest shoes *O* and *D*. These have carbide faces that contact the quill just ahead of the cutting tools. A slot *E* carries a cutting tool *F* and is a sliding fit in block *A*. This slide is held in place by a cover plate *G* through which, and at right angles to the cutting tool-slide, passes a cold-drawn steel bar *H*. The bar has a portion milled away, and in this recess the template *J* is fastened. Two blocks (not shown) are clamped to the lathe bed and to these bar *H* is fastened.

The template hinges on a tight-fitting screw at one end and has a slot for a clamping screw at the other end. This slot permits swinging the template for fastening at the desired taper. The template is made of flat, hardened and ground stock. A swinging follower has a stylus *T* which rides the form surface of the template. The follower is held against the coil compression spring *L* in a slot in slide *E*, pressing against one end of the slot and loaded against flattened pin *M* carried by block *A*.

The illustration shows the cutting tool ready to start a cut. As the carriage moves, the follower rides along the edge of the template, which is a negative of the form that will be cut in the aluminum quill. At the finish of the pass, the feed of the lathe automatically stops. The carriage is returned manually, with the follower swinging away from the template. It is swung into place again at the start of a fresh cut. Time of the operation is about one-half minute. Shoes *O* and *D* are carbide-tipped steadyrests to take the cutting thrust of the tool. They are fastened to an extension of the base.

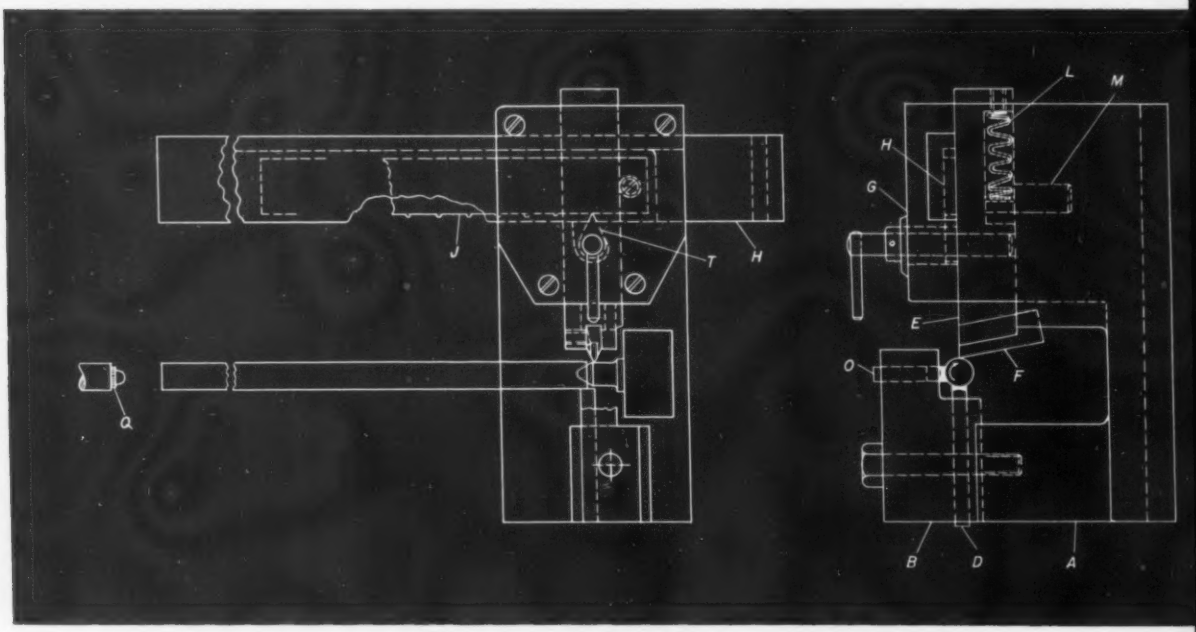
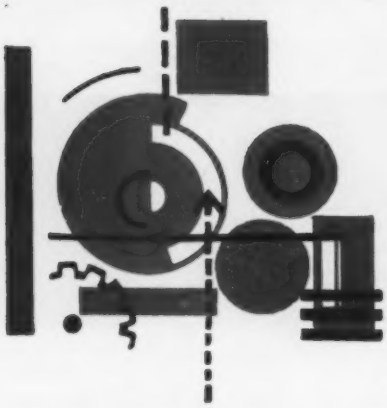


Fig. 2. Mechanical tracer generates taper and cuts grooves in textile machine quill, Fig. 1.



Ingenious Mechanisms

Mechanisms selected by experienced machine designers as typical examples applicable in the construction of automatic machines and other devices

Lathe Attachment Hobs Worm-Wheel Segment with Fractional Number of Teeth

ERNEST E. NOVEL, Geneva, Switzerland

Use of the metric system is being extended in interesting ways in Switzerland. In fact, it is replacing the usual 360 degrees of arc in a circle. An example is a 100-space calibrated dial for a crank adjustment on a Swiss cannon mount. In order to correct for errors in laying the gun on a

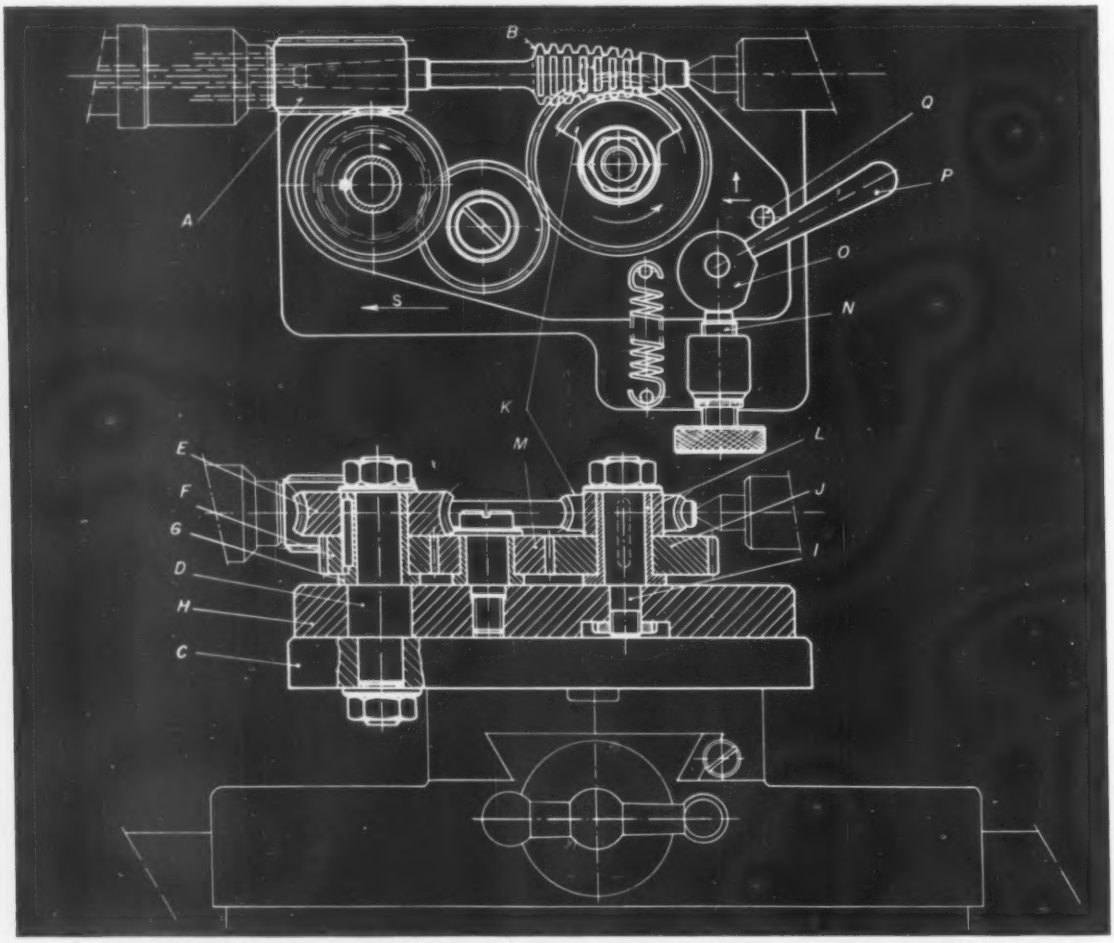


Fig. 1. Work-piece sector (K) is fed into the hob (B) by advancing screw (N). The top view shows how the sector (K) is synchronized with the hob through the gear train and worm (A).

target 1000 meters away, the artillery-man turns the crank as before, but now he can turn the crank one space which represents one meter and 1 per cent if he is off target one meter. The calculation is thereby simplified and can be done mentally.

The hand crank drives a worm in mesh with a sector of a worm-wheel cut with an unusual number of teeth. If the wheel were a full circle, it would have 62.8 teeth. Note that the angular distance between two adjoining teeth is

$$\frac{360^\circ}{62.8} = 5^\circ\ 44'$$

and that

$$\sin \text{ or } \tan 5^\circ\ 44' = 0.1 \text{ or } 100 \text{ per cent}$$

with an extremely small error. The sectors are made on an engine lathe using the following technique:

On the spindle, Fig. 1, is chucked a worm *A* into which is adapted hob *B* by taper shank and drive, its right-hand end centered in the tailstock. Worm *A* has the same lead as the hob. In this case, it has a single-start thread and its pitch is therefore the same as that of the sector *K*. On the lathe's cross-slide, instead of the toolpost, is fastened a baseplate *C* which bears a pivot shaft *D* on which worm-wheel *E* and gear *F*, coupled by keyed bushing *G*, rotate. By advancing the cross-slide, worm-wheel *E* will mesh with worm *A* without backlash. A second plate *H* is set upon baseplate *C*, arranged to swing on pivot shaft *D*. Plate *H* mounts a stud shaft *I*, on which gear *J* and sector *K*, coupled by keyed bushing *L*, rotate. Gears *F* and *J* are in train with idler *M*, which is also mounted on a shaft in plate *H*. Plate *H* is held by a tension spring against set-screw *N*, whose nut is fastened to baseplate *C*. The set-screw bears against cam *O*, which permits sector *K* to be backed away from the hob while worm-wheel *E* remains in mesh.

Therefore, when the lathe is stopped and its carriage is moved to the left, worm-gear *E* will rotate clockwise in mesh with worm *A* which, at this point, acts as a rack. Therefore, sector *K* also will rotate. Owing to its gear ratio, it will remain in synchronism with hob *B*.

When the headstock is started it is possible to move the carriage to the left or to the right without losing synchronism. Thus this device acts as a differential which enables the worm-wheel sector to be hobbed tangentially using a slow carriage feed from the right to the left. Obviously it would be impossible to hob these sectors on a conventional gear-hobbing machine because, on the second time around the work, the hob would interfere with the teeth partially cut on the preceding revolution of the sector.

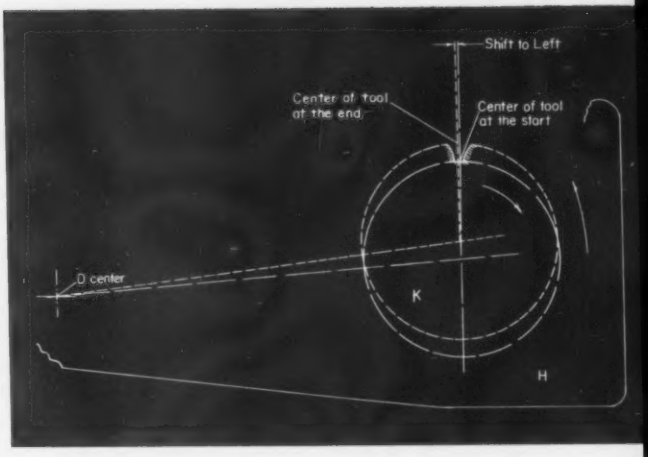


Fig. 2. The whole plate (H) pivots around shaft (D) carrying the center of the work into the hob. This sketch shows, in exaggerated form, how the work center shifts to the left.

Hobbing proceeds as follows: the hobbing depth is set by means of screw *N* and with handle *P* pushed against stop *Q*. The lathe is started and the carriage is carefully moved by hand to the left until the tapered part of the hob begins to graze sector *K*. Next the proper carriage feed is engaged. When the last tooth of the sector has passed the hob the carriage feed is disengaged immediately. A pull on handle *P* disengages the sector from the hob and the lathe spindle is reversed. As soon as the sector returns to its initial angular position, the spindle is stopped. The carriage, which has carried the work-piece center a little to the left during the first pass, dwells during the idle return. For the next cut, handle *P* is swung back against pin *Q*, set-screw *N* is advanced, the carriage feed is re-engaged, and the lathe is started in forward direction again. During this second pass, the carriage moves the work center a little more to the left. The cycle repeats this sequence of operations as many times as is necessary to cut the teeth full depth. Finally the carriage is returned to the right by hand to its starting point. When the sector has been removed the lathe is ready for hobbing a new piece.

The hob is a standard tool. Fig. 2 describes how this hob can cut a nonstandard number of teeth in the sector. The pivoting of plate *H* and the work-piece about the center *F* as the cut deepens has the effect of shifting the center of the work-piece to the left. Therefore the net effect is that the work center *gains* on the hob the equivalent of one-fifth the length of a single tooth, providing the sector is a full circle at full depth of the cut, accounting for the 62.8 tooth count on the basis of 360 degrees.

Recent Advances in High-Energy-Rate Forming

AT A TWO-DAY High-Energy-Rate Forming Seminar presented recently in Detroit, Mich., by the American Society of Tool & Manufacturing Engineers, experts from throughout the country discussed the latest developments and their experiences with these production processes. The high-energy-rate metalworking techniques described included explosive, combustible-gas, pneumatic-mechanical, and electrohydraulic forming methods.

Floyd Cox, manager of manufacturing research and development at Ryan Aeronautical Co., stated that the most promising applications for explosive forming were the replacement of multiple-part designs with one-piece construction, the production of large parts that would be impractical or impossible to make in any other way, and the forming of newer materials that are difficult to shape by more conventional methods. One example cited was an engine shell that was redesigned from 129 components required in the previous method of fabrication to a single part made by explosive forming.

When heat is required to explosively form parts from certain materials, and where the tool and part cannot be placed in the water tank, Ryan uses sand as the pressure transfer medium, and electrically heats the die and hold-down ring. Chemical milling is sometimes used in the preparation of special blanks, or to produce uniform thickness of explosively formed parts. Best results have been obtained at Ryan with ductile-iron dies. However, for large parts, where equipment is not available to machine huge dies, it is necessary to use fiberglas or epoxy-resin lined, reinforced concrete dies. In such cases, difficulty has been experienced in obtaining a good bond between the plastic facing and the concrete. In sealing the dies for explosive forming, good results have been obtained with square cross-section, beveled-end rubber seals that project only about 1/64 inch above the top face of the die. For elevated-temperature forming, asbestos is used as a sealing material.

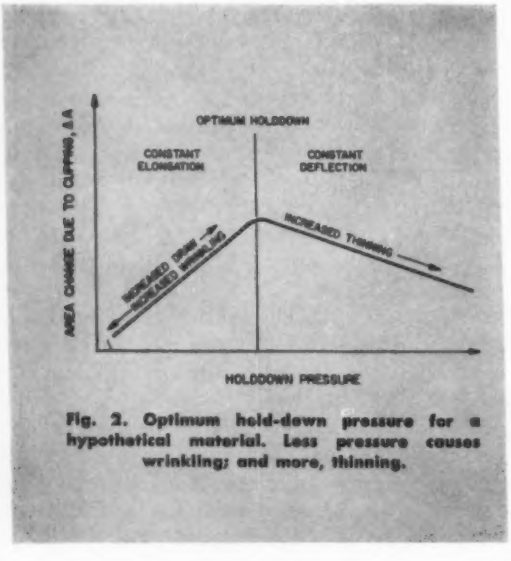


Fig. 2. Optimum hold-down pressure for a hypothetical material. Less pressure causes wrinkling; and more, thinning.

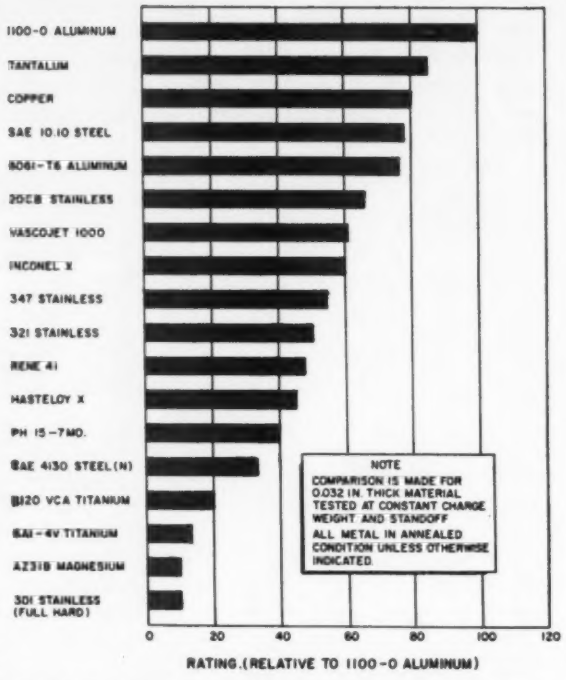


Fig. 1. Comparative formability of various materials determined in a series of explosive-forming cup tests.

E. E. Lockwood, senior research engineer of the Rocketdyne Division, North American Aviation, reported on his company's investigation into the explosive formability of metals. A simple cup test was employed to determine the relative formability of various materials when blanks 7 1/2 inches in diameter by 0.032 inch thick were subjected to a single underwater explosion occurring at a standoff distance of 18 inches. The results are shown in the accompanying bar graph, Fig. 1. Other tests showed that draw and stretch increase in proportion to the square of the central deflec-

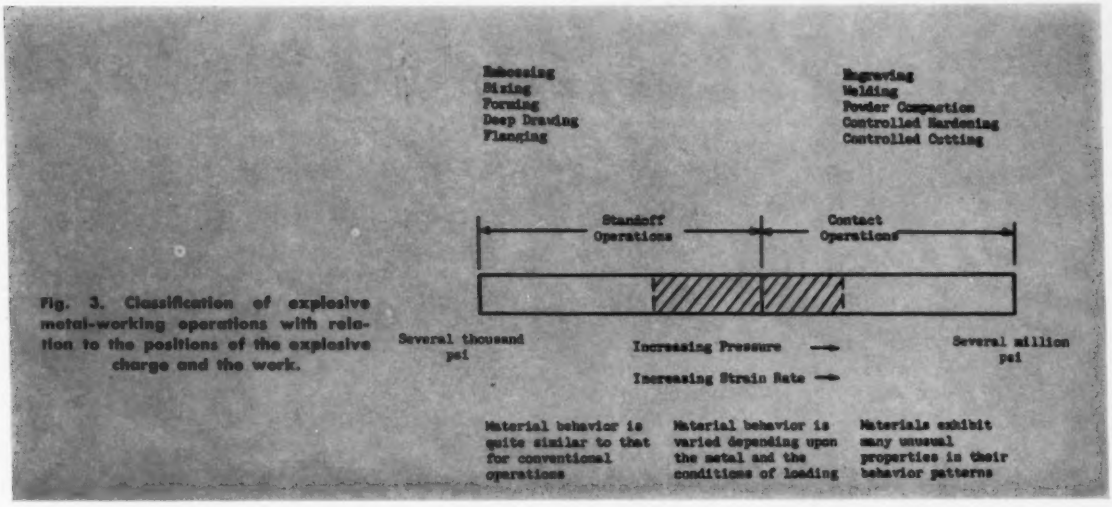


Fig. 3. Classification of explosive metal-working operations with relation to the positions of the explosive charge and the work.

tion for the thin material. Also, the ratio between draw and stretch remains constant.

Mr. Lockwood also stated that the tests verified the theoretical prediction that the depth of forming varies inversely with the square root of the work-blank thickness. In explosively forming the tougher materials, the action of the pressure from the hold-down plate is that of ironing. Wrinkling of the materials is prevented by high hold-down pressures. However, too great a clamping pressure will cause excessive stretch or thinning. As a result, an optimum hold-down pressure must be determined experimentally for each material. The optimum hold-down pressure for a hypothetical material is indicated schematically in Fig. 2.

John Pearson, head of the detonation physics group at the United States Naval Ordnance Test Station, China Lake, Calif., made an interesting classification of explosive metalworking operations. Most of such operations in use or under consideration can be divided into two groups, Fig. 3, depending on the position of the explosive charge relative to the work-piece. The first group (right) consists of those in which the charge is placed in intimate contact with the work-piece. The second group (left), classed as standoff operations, includes those operations where the charge is located some distance from the work-piece, and the energy is transmitted through an intervening medium such as air, oil, or water.

Explosive forming with gas mixtures, one of the latest developments in high-energy-rate forming, was described by Richard E. Lingen, supervisor of the manufacturing development section, Aero-Space Division, the Boeing Airplane Co. A major advantage of the process, shown schematically in Fig. 4, is that the gas mixture assumes the shape of the container, thereby becoming an optimum-shaped charge regardless of quantity.

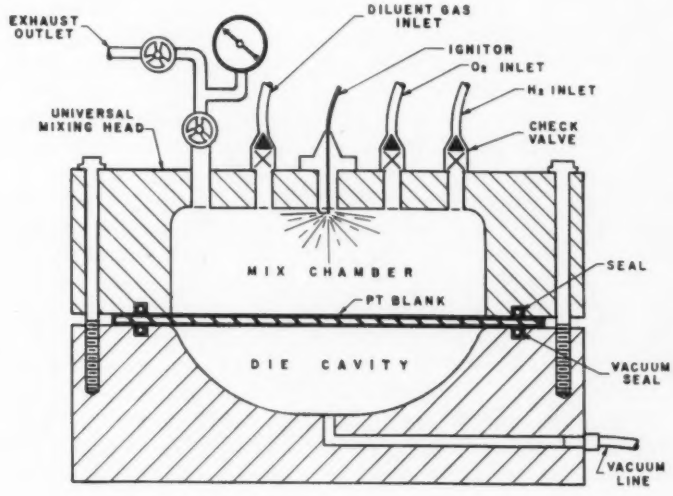


Fig. 4. Schematic drawing of the method used at Boeing for high-energy-rate forming by means of gas mixtures.

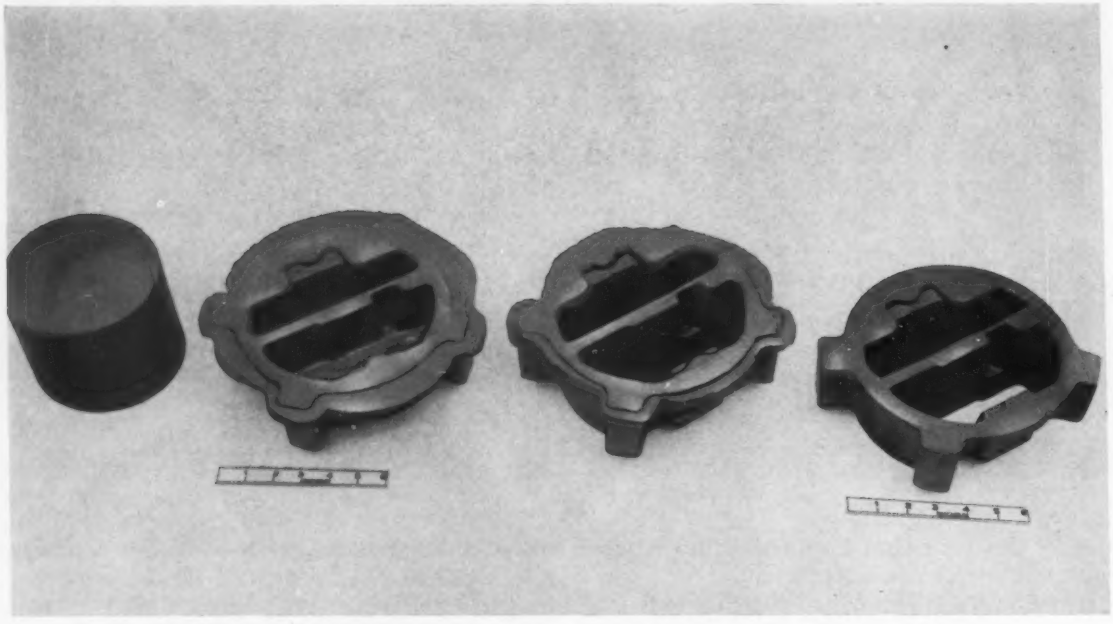


Fig. 5. Variable-speed engine control housing originally cost $1868. Now produced on a Dynapak machine, it is sold for $68.

Also, the charge is in intimate contact with the work-piece, the need for a water tank or pit is eliminated, and more rapid production and better control are possible. Disadvantages are that it is not suitable for thick materials, and hot-forming is not feasible.

At Boeing, separate sources of pressurized fuel, reagent, and inert gases are provided, each with individual controls. The mixing chamber can be made part of the forming tool, or a universal mixing head, adaptable to any tool, can be provided. Good sealing and a fail-safe (pressure relief) chamber are essential. Ignition can be of the glow wire, spark plug, or cap types. Oxygen and hydrogen is used for the explosive gas mixtures, with nitrogen employed for purging the chamber. For additional control of the process, an inert gas such as nitrogen, helium, argon, or carbon dioxide is used as a diluent.

Deflagration (rapid burning) occurs when the gas mixture is properly ignited. This desired response creates a predictable pressure time and peak which can be controlled. Detonation (explosion) is not desired, at least at this stage of the art, because of the unstable conditions and unpredictable results. However, detonation may occur under certain conditions, with overpressures of up to fifty times the initial pressure and possibly catastrophic results. Tooling requirements are about the same as for conventional explosive forming, except that the die-chamber material must be capable of transmitting heat readily. This requirement excludes the use of plastic materials.

Joseph M. Palsulich, research engineer with Western Gear Corporation, Lynwood, Calif., described his company's experience with the pneumatic-mechanical method of high-energy-rate forging on a Dynapak machine made by the Advanced Products Division of General Dynamics Corporation. One part displayed, Fig. 5, produced by the Precision Forge Co., Santa Monica, Calif., on another Dynapak machine, represented a cost saving of 96.7 per cent. This forging, made from Type 410 stainless steel as a variable-speed engine control housing for a supersonic bomber, originally cost $1868 to manufacture. Now, as a high-energy-rate forging, it is sold for $68. The parts shown in Fig. 6 resulted in a materials saving of 63.6 per cent. The part on the left was forged on a Dynapak machine. It weighs 4 pounds and has only 0.030 inch of stock left for cleanup machining. The forging on the right, made on a drop-hammer, weighs 11 pounds. Both forgings were made from Type 347 stainless steel. In most cases, no draft is required on forgings made by this high-energy-rate method.

Thomas S. Riordan, master mechanic at the Utica Division of the Bendix Corporation, also discussed experiences with the Dynapak forming press. His company has followed the single-blow, closed-die concept on this machine, as opposed

to the multiple-blow, open-die method employed by other users. The punch is either piloted in the die, with allowances for side flash, or the clearance between punch and die is only sufficient to allow a maximum of 0.050-inch flash. Stepped billets are sometimes used to facilitate positive location, since float cannot be tolerated, especially on larger-diameter and shorter parts.

At Bendix-Utica, various lubricants and coatings, such as litharge and peanut oil, copper plating, a special ceramic coating, and glass dispersed in alcohol, have been tried. Most successful results have been obtained with an aqueous suspension of graphite, which is used to coat the die, not the billet. This lubricant has permitted extensive metal flow with no adhesion, and the pressure required for firing the Dynapak machine is minimized.

Punches and dies are preheated to 350 degrees F. before being used on the Dynapak machine. The heat transfer in forming hot billets is adequate to maintain this temperature during operation. Formed parts are placed in lime after forming to minimize scale formation and reduce the cooling rate. For general applications, punches are made from S-1 shock-resistant tool steel, which is purchased in the fully annealed state. After machining, the punch is hardened and triple-tempered to a hardness between 48 and 50 Rockwell C. Dies are made from vacuum-degassed, upset-forged, fully annealed H-13 hot-work die steel. After machining, the dies are hardened and triple-tempered to a hardness between 50 and 52 Rockwell C. Tool life varies with the complexity of the parts being formed, but is generally longer (up to five times as much) than with conventional hot-forging because of the shorter contact of the hot billets with the die. One die set has been used to form 2400 pieces without the need for re-dressing. During the past year of producing parts on the Dynapak machine, Bendix-Utica has realized a return on their initial investment of nearly 100 per cent.

Robert Felts of Electro Dynamics, Detroit, Mich., discussed the application of the electrohydraulic effect to metal-forming. The electrohydraulic effect is the direct creation of hydraulic pressure, for a very short period of time, by means of electricity. In the exploding wire technique, the wire is melted and vaporized, surrounding water confines the vaporized wire, the metal vapor continues to carry current which generates more heat, the vapor channel expands, and the water surrounding the vapor channel is compressed and forced outward radially. Another method of converting electrical energy to hydraulic energy, which follows about the same sequence of events, uses a simple spark-plug type of electrode as the transducer.

The tank used for electrohydraulic forming may be open or closed. A good vacuum is required in the die cavity during forming, and the blank must be sealed to the die. A wide variety of metals have been formed successfully by the electrohydraulic process, ranging in size from 3 to 48 inches in diameter, and from 0.030 to 1 inch thick. Simultaneous forming and flanging can be performed in the same die.

Fig. 6. Dynapak forging at left weighs only 4 pounds, compared to the 11-pound forging at right, produced on a drop-hammer.

NEW DEVELOPMENTS IN

Machine tools, unit mechanisms, machine parts, and

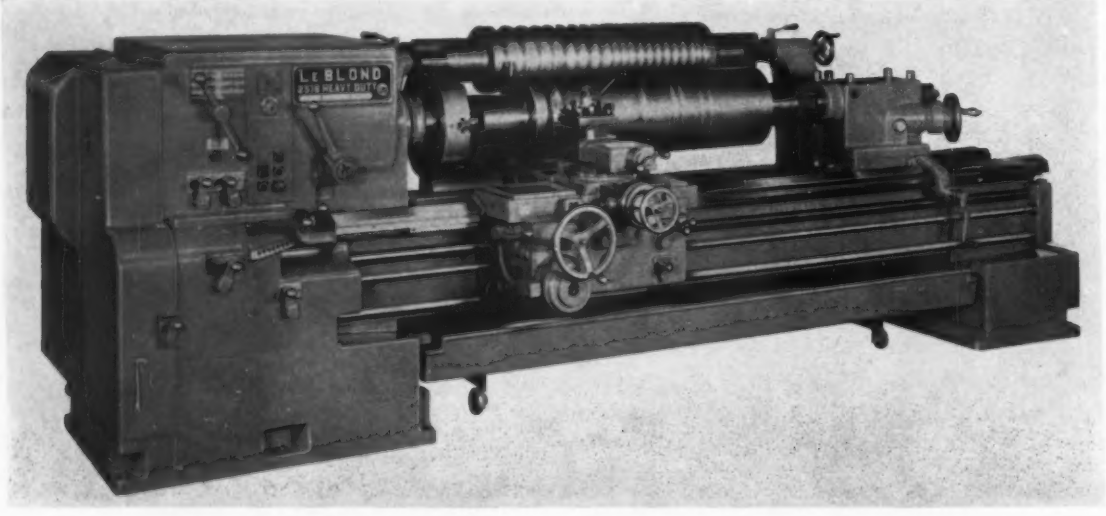
LeBlond Heavy-Duty, High-Power Lathes

The newest of machines in the line being redesigned by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, are the heavy-duty lathes NF 2516 and NF 3220. These lathes have been designed to incorporate the features required to give outstanding performance in this 40-hp class. Bed widths, especially, are indicative of their heavy-duty ruggedness. The NF 2516, with a 25-inch swing over the bed and 16-inch swing over the cross-slide, has a 22 3/4-inch wide bed; and the NF 3220, a 24 1/2-inch wide bed.

The extreme rigidity and high power of these lathes make them equally well suited for hogging cuts and ultrasmooth finishing. They can be used both for turning heavy forgings and delicate toolroom work on precision missile components. Lathes in these sizes are especially adapted for use in ordnance and heavy-machinery shops. Fitted with LeBlond's 90-degree tracer, they are ideal for turning bar mill and similar steel mill forming rolls.

Both the NF 2516 and NF 3220 have thirty-six spindle speeds, in three ranges from 10 to 1300 rpm. They offer sixty feed and thread changes, with standard feeds ranging from 0.0045 to 0.269 inch. Both are rated for 40-hp motors. The lathes may be obtained in toolroom models. The NF 2516 is built in a plain bed gap model, which increases the swing approximately 50 per cent through the use of the gap arrangement.

Circle 565 on Readers' Service Card



Redesigned NF 2516 heavy-duty lathe announced by the R. K. LeBlond Machine Tool Co.

Edited by Freeman C. Duston

SHOP EQUIPMENT

material-handling appliances recently introduced

Bendix Tape Positioning Control that is Accurate to 10 Millionths Inch

The Bendix Corporation, Industrial Controls Section, Detroit, Mich., has produced a number of tape positioning controls for a new precision measuring machine developed by the Sheffield Corporation, subsidiary of Bendix Corporation. The Bendix control system, designated DynaPoint-25, can be built to control two, three, four, or five axes of machine motion. These modular, transistorized systems are available in a range of resolutions from 0.001 to 0.000010 (10 millionths) inch to fit a variety of machine tool applications.

The Sheffield five-axis precision measuring machine is designed to gage inside and outside contours accurately, rapidly, and simultaneously. It has an electronic resolution of 0.000010 inch on each of four linear motions and 0.36 degree on one rotary motion. The control system provides electrical signals that position the measuring probes to the specified dimensions. Two Sheffield Electrojet probes measure the deviation between these specified positions and the part being gaged.

A typical inspection of a conically shaped part might include 795 measurements and 265 automatic mathematical computations for a wall thickness. This can be accomplished automatically in less than two hours on the Sheffield/DynaPoint system. It formerly required up to 125 hours to do the same job to the same accuracies.

Gaging a transparent part with new Bendix DynaPoint controlled Sheffield precision measuring machine

Circle 566 on Readers' Service Card

Avco PlasmaGun

A compact, lightweight PlasmaGun designed for industrial use has been announced by Avco Corporation, Research & Advanced Development Division, Wilmington, Mass. Only 5 inches long and weighing 3 1/2 pounds, it was designed to provide a practical, ver-

Lightweight PlasmaGun introduced by Avco Corporation

satile production tool that is simple and reliable. The entire gun assembles with only four bolts securing precision-machined, self-aligning, piloted parts.

It is designed to spray coatings – including refractories – with a controlled thickness, density, and bond strength not previously obtainable. It deposits a coating at an exceptionally fast rate and at low costs. The gun has integral adjustable cathode control. High regulation of powder feed by an electromechanical system using a vernier control permits the use of powders that previously were considered too fine for plasma guns. The Avco complete PlasmaGun system includes the gun, control console with self-contained powder feed, a power supply, and spray booth.

Circle 567 on Readers' Service Card

Adjustable Microbore Carbide Cutting-Tool Cartridge Units

The addition of three new tool shapes to its standard line of adjustable Microbore cartridge units, the modification of two existing standard shapes, and the expansion of tool styles in the small-size cartridge (3/16-inch diameter) are announced by the Microbore Division of DeVlieg Machine Co., Royal Oak, Mich.

The three new shapes are for chamfering operations when machining with standard adjustable Microbore units. These are now offered in all sizes from 1 through 10 (3/16- through 1-inch diameters) and referred to as Styles 24, 54, and 9. Style 24 is a 45-degree chamfering tool when mounted at the standard Microbore tool angle. Style 54 is a 45-degree chamfering tool when mounted at 90 degrees in a boring-bar. In certain applications both styles can be used for boring as well as chamfering. The Style 9 tool is a square-end cutting-edge cartridge that can be used for chamfering angles other than 45 degrees, when mounted at the required angle, or it can be used as a plunge-facing tool.

Tools with modified shapes are the two solid carbide-tipped ones formerly produced as Style 1, for angular mounting, and Style 4, for 90-degree mounting—in the size 1 (3/16-inch diameter) cartridge. These now are designed to use carbide blanks brazed in milled pockets, and identified as Style 2, for angular mounting, and Style 5, for 90-degree mounting. Prior to this modification, Styles 2 and 5 were produced by the company in all sizes, except in the size 1 cartridge.

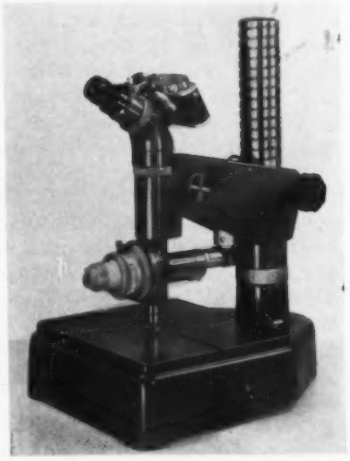
Through the adoption of the milled pocket cartridge blank, the manufacturer also offers, for the first time, a Style 3 Microbore cartridge in size 1. In machining, this cartridge allows wider facing operations to be performed when angular-mounted. All tools are available in all standard carbide grades, with standard rake angles, in both long and short (A and B) lengths. The illustration shows, from right to left, front row, sizes 1, 2, 3, and 5; back row, sizes 7 and 10.

Adjustable Microbore cartridge units of latest styles brought out by Microbore Division of DeVlieg Machine Co.

Circle 568 on Readers' Service Card

Leitz Light-Wave Surface Tester

An interference microscope for checking highly finished surfaces is being offered in the Leitz light-wave surface tester by Opto-Metric Tools, Inc., New York City.



Instrument for checking highly finished surfaces announced by Opto-Metric Tools, Inc.

As the name implies, the instrument determines the smoothness of surface finish interferometrically, without making actual contact with the surface under test. This has become an accepted practice for critical and delicate surfaces during the past few years.

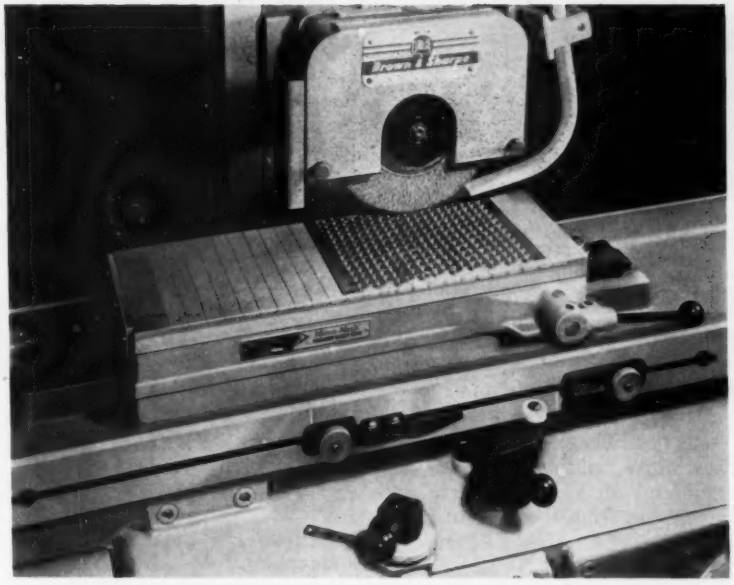
The instrument employs the Michelson beam-splitter method, and measurement is in terms of light waves. A choice of three interchangeable magnifications of 100×, 200×, and 500× is standard equipment.

Circle 569 on Readers' Service Card

Brown & Sharpe "Micro-Mesh" Chuck

The Brown & Sharpe Mfg. Co., Providence, R. I., has brought out a "Micro-Mesh" permanent-magnet chuck with a newly designed close-spaced pole arrangement that utilizes barium-ferrite (ceramic type) magnets. This chuck permits machining of small, thin work (from 0.001 inch). In working tests, thickness gage stock 2 1/2 inches long by 3/8 inch wide was ground to a thickness of 0.0008 inch on a surface grinder, with 1/8 inch of the wheel cutting at the rate of 0.0001 inch per pass.

Sliding tests on the Micro-Mesh chuck show a holding power of 2 1/2 psi for a piece 0.008 inch thick, or about 250 per cent more power than conventional chucks. Because holding power over the entire magnetic surface is uniform, the Micro-Mesh chuck can be used fully loaded for maximum production. The usual weak zone in the handle area has been eliminated by locating the handle shaft support mechanism on the chuck exterior. Over-all width, including lever, is maintained at 9 1/16 inches.



Micro-Mesh permanent-magnet chuck, made by Brown & Sharpe Mfg. Co., used for grinding spacers to 0.025-inch thickness

This 618-4 Micro-Mesh chuck also provides long-sought holding power in toolroom and inspection applications. It has 6- by 18-inch working surfaces, 6- by 15 3/4-inch magnetic surface, and 6- by 18-inch base dimensions. The height is 2 1/2 inches, and the length is 22 7/16 inches.

Circle 570 on Readers' Service Card

Ex-Cell-O Machine Equipped to Turn Tough Work-Hardening Steel Alloy

A Model 308 cam-operated precision boring machine built by the Ex-Cell-O Corporation, Detroit, Mich., is equipped as shown in Fig. 1 to produce a turbulence-chamber component of tough, work-hardening alloy steel. One end of the part is machined at the front spindle (see Fig. 2), and after reloading, the other end is machined at the rear spindle, resulting in the completion of one part at each cycle.

The cycle commences as the spindle slide rapid-traverses toward the right. The small interrupted diameter is turned, followed by the taper turning. After a dwell, the machining includes facing the shoulder, turning the outside diameter to size within 0.0005 inch, and turning the step diameter. A rapid-traverse motion brings the tools toward the workpiece at the rear spindle. Here the

Fig. 1. Ex-Cell-O precision boring machine equipped to turn tough part

end is faced, chamfered, and turned, followed by facing of the shoulder face. At the completion of this operation the table again moves and the annular grooves in the shoulder faces of both parts are cut simultaneously.

The Ex-Cell-O cam-operated precision boring machine is especially adapted for producing multiple diameters and contours to close tolerances. Repeatability is assured, since all tool motions are controlled by accurately ground cams. The cam followers for both table and cross-slide engage directly; there are no intermediate levers or linkages. The entire cam assembly and its drive are mounted on a hinged plate and swing out from the base to facilitate rapid cam change-over.

Circle 571 on Readers' Service Card

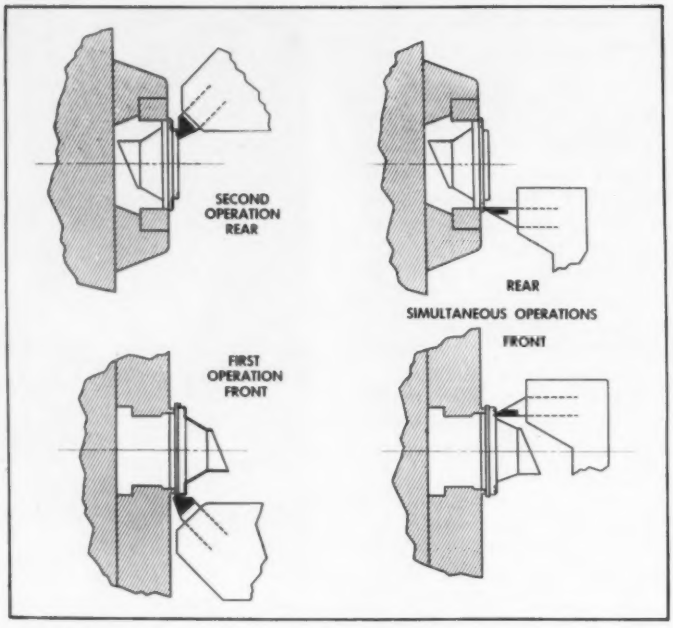


Fig. 2. Machining operations performed by Ex-Cell-O machine, Fig. 1

Instrument for Checking Lead of Helical Gears and Splines

An instrument has been developed by Michigan Tool Co., Detroit, Mich., for production-checking the lead on helical gears and splines made by Sundstrand Aviation, a division of Sundstrand Corporation. Work inspected on this Model 1218 checker varies from external helical gears for jet-engine starter turbines (illustrated) to internal splines. The instrument is capable of repetitive accuracy within 0.0001 inch. Every check is automatically recorded on a paper chart.

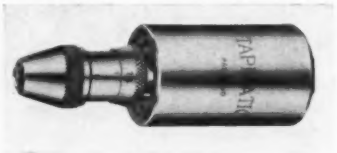
An important feature of this lead checker is the optical system —which is independent of operator "feel"—used to set the universal sine bar to within 0.001 degree of the required angle. This feature was designed to improve setup accuracy of the instrument in a gear laboratory, but is especially important in this production application, where high-speed checking is essential.

Circle 572 on Readers' Service Card

Helical gear and spline checking instrument made by Michigan Tool Co.

Tapmatic Drill Speeders

Exceptionally high-speed ratios are attained by a new line of gearless drill speeders brought out by the Tapmatic Corporation, Costa Mesa, Calif. This has been made possible by a unique, compact all-ball-bearing design. The Tapmatic drill speeder Model 62, for example, has a standard ratio of 7 to 1 although it weighs only 9 ounces and has a major diameter of 1 5/16 inches. With these speeders small-hole drilling can be efficiently performed on machines with relatively low maximum spindle speeds. Drilling speeds up to 22,500 rpm are possible even on machines which have maxi-



Ball-bearing drill speeder introduced by Tapmatic Corporation

mum spindle speeds of only 1500 rpm.

The complete elimination of gears in the construction of these drill speeders assures quiet, vibrationless operation. This is an important advantage in small-hole drilling. The drill speeders are manufactured with threaded or tapered mounts for universal application on all types of manual, semiautomated, or completely automated drilling machines. Rugged, heat-treated, and ground components serve to insure trouble-free performance. The Tapmatic drill speeder Model 62 has a capacity for drills from No. 80 to 1/16 inch, with the standard ratio of 7.00 to 1 or the optional ratio of 2.75 to 1. Model 125 has a drill capacity of No. 80 to 1/8 inch, with the standard ratio of 6.25 to 1 or the optional ratios of 2.50 to 1 and 15.50 to 1.

Circle 573 on Readers' Service Card

Vertical Dual-Ram Combination Surface and Internal Broaching Machine

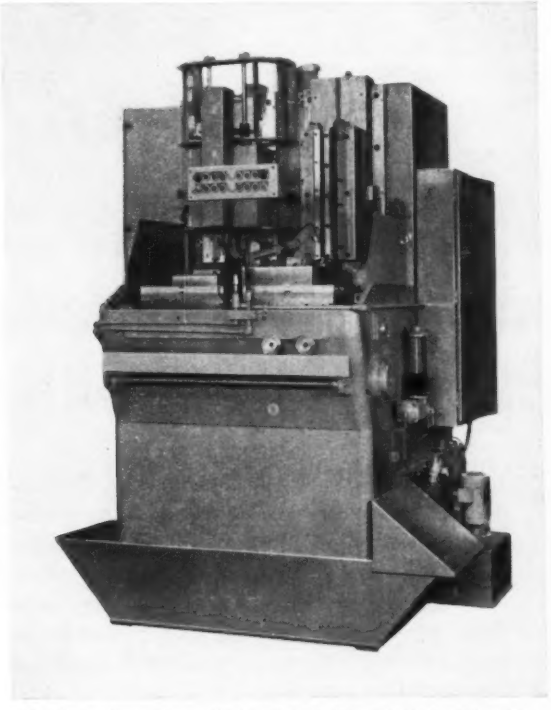
A machine which performs two distinctly different types of broaching operations has been developed by the Detroit Broach & Machine Co., Rochester, Mich. This new machine is said to be capable of making tremendous reductions in the cost of processing a wide range of parts in metalworking plants. It has been designed to perform the same amount of work that normally would tie up two different machines for an investment less than that required for two single-purpose machines. It is a 5-ton, 42-inch vertical dual-ram combination surface and internal broaching unit. Operating at speeds of 45 fpm, it can be employed to perform two different operations on different workpieces, or on the same work-piece. In either event, only one operator is required, mainly to manually load and unload parts with a minimum of motion. Floor space occupied by the machine and its auxiliary components is about two-thirds of that usually reserved for two machines.

Alternating action of the rams enable an operator to handle the work with ease. He unloads and loads work at one ram position while work is being broached at the other. In a part requiring both an internal and external operation, a finished piece can be produced in one complete cycle. Also, in certain applications, the machine can be arranged for automatic loading and unloading.

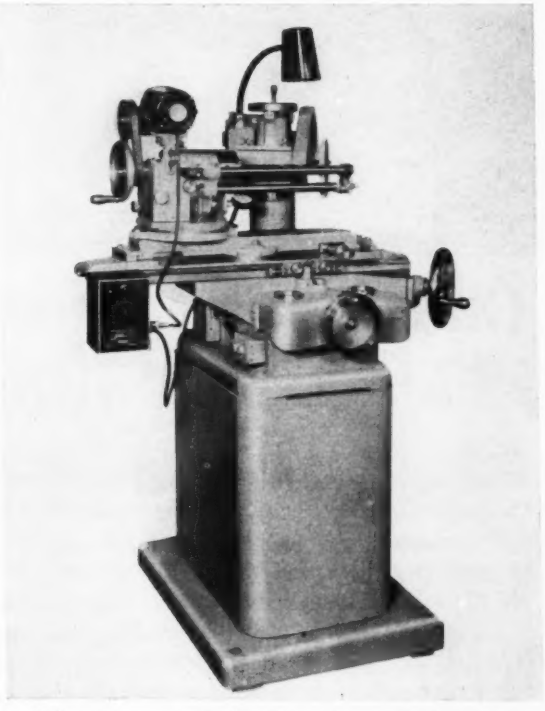
Circle 574 on Readers' Service Card

Universal Two-Way Relieving Fixture

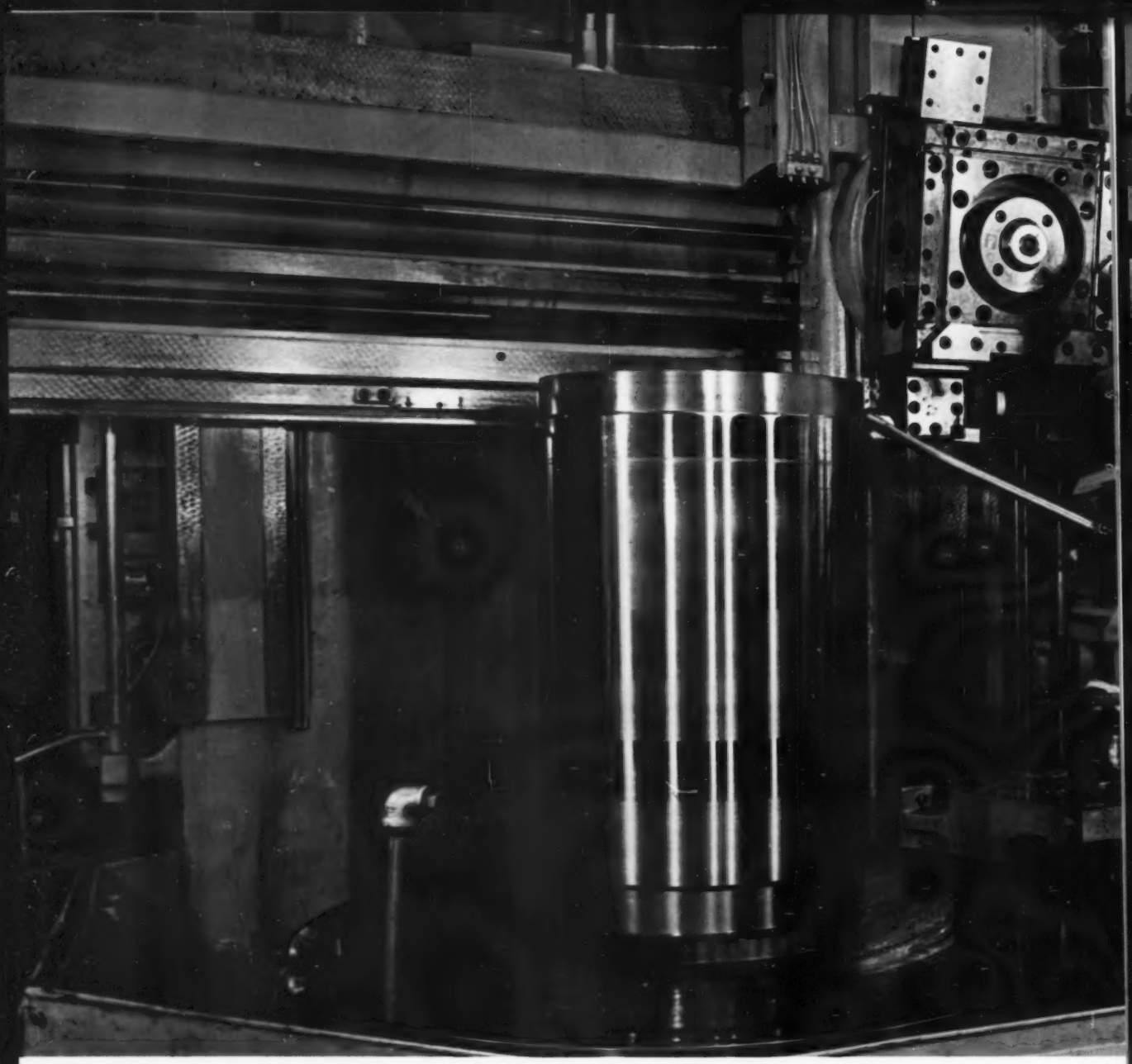
A universal two-way relieving fixture for grinding radial relief only, axial relief only, or any combination of radial and axial relief, and plain circle grinding, has recently been announced by the Henry P. Boggis Co., Cleveland, Ohio. This new Hybco fixture is available with the company's Model 1900 grinding machine or separately for use on the purchas-



Dual-ram broach made by Detroit Broach & Machine Co.



Hybco two-way relieving fixture for cutter sharpening

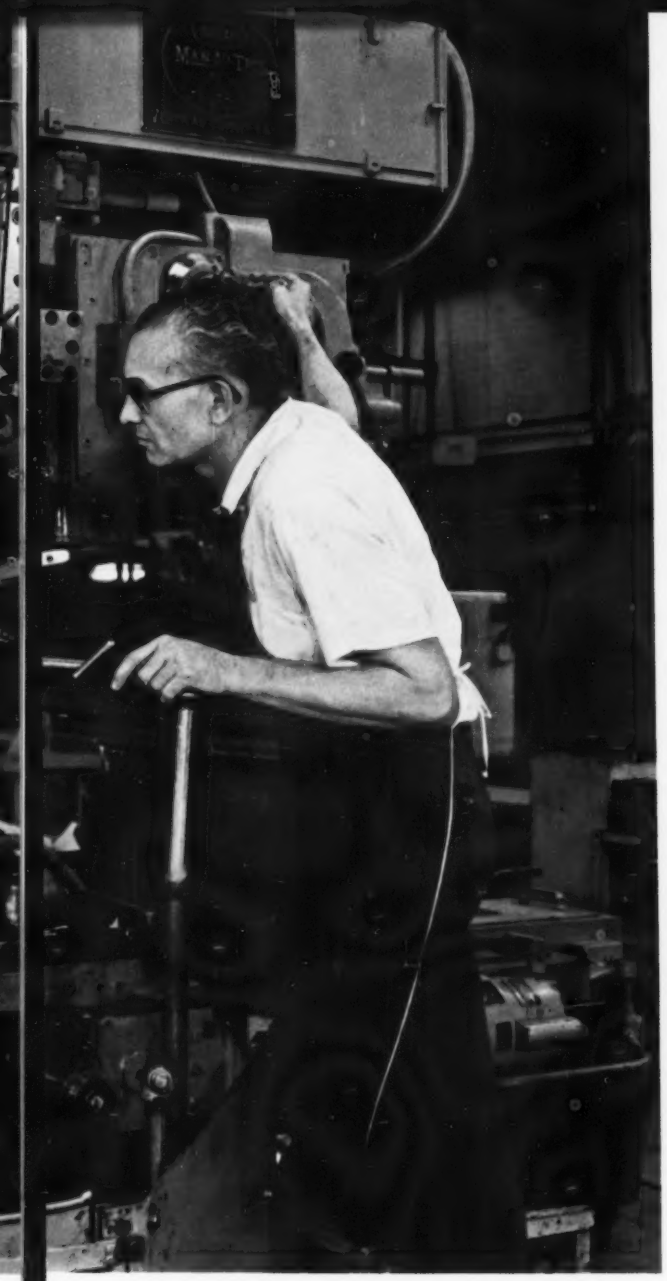


Chance Vought trims production costs with three Gulfcut® oils . . .

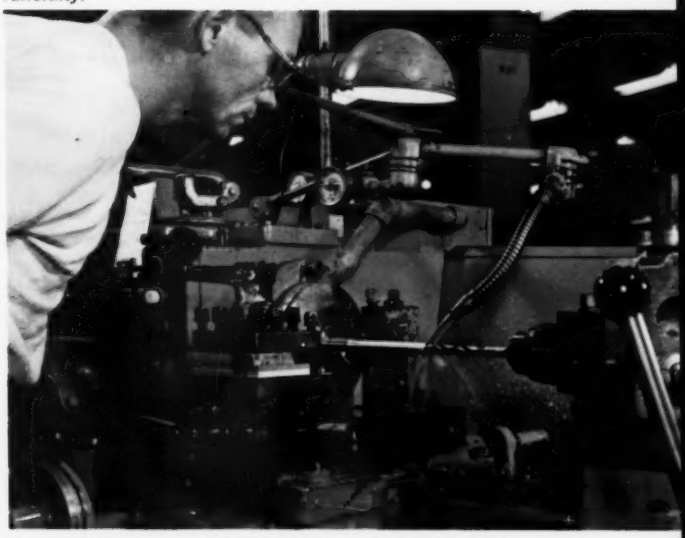
Machining operations at the Dallas, Texas, plant of Chance Vought, a subsidiary of Ling-Temco-Vought, Inc., seemed to require an inventory of dozens of limited-purpose cutting fluids. But the large inventory contributed to cutting oil misuse that increased production costs. However, Chance Vought solved this problem with three Gulf cutting oils.

To simplify cutting oil selection, Chance Vought classified machining operations by category. Example: difficult machining jobs involving tough cutting and draggy ferrous metals. Here, Gulfcut 45B is used because it contains an extra-heavy concentration of sulfur, chlorine and fatty oil for excellent load-carrying and anti-weld features.

Another example: aluminum, magnesium and other non-ferrous machining operations where staining is highly objectionable. A versatile compounded mineral-lard oil, Gulfcut 11D, is used on this type of job. This oil's light viscosity also suits it for blending with other oils for special jobs.



Ex-Cell-O thread grinder. Workpiece is a special bolt trunnion attachment of AISI 4130 steel. Excellent tool life is obtained with Gulfcut 41TG. Operators report no rancidity.



Warner & Swasey No. 3 turret lathe. In position is an oil level indicator for an aircraft primary hydraulic system. Gulfcut 11D (light viscosity) keeps chips flowing freely.

Bullard vertical turret lathe. Workpiece is an AISI 4340 steel holder for an explosive die in which aircraft parts are formed. Gulfcut 45B is the cutting oil.

and cutting oil inventory
GULF MAKES THINGS RUN BETTER!

Next, there is thread grinding. The volume and nature of this operation dictates the use of a specially compounded thread-grinding oil. Gulfcut 41TG is used. This oil provides good finish, accurate tolerances, long wheel life. In addition, it contains an anti-foam agent and corrosion inhibitor—both important in circulating systems of thread-grinding machines.

"As a result," says Doy Stanley, General Foreman, Facilities,"we've been able to make notable purchasing economies. What's more, we've lowered over-all maintenance and production costs by lessening the risk of cutting oil misuse."

There's a right combination of Gulfcut oils to help cut your machining costs. For additional information call a Gulf Sales Engineer at your nearest Gulf office. Or write for Gulfcut literature. Gulf Oil Corporation, Dept. DM, Gulf Building, Houston 2, Texas.

GULF

SP 10196

er's tool and cutter grinder. The relieving fixture can be furnished with swivel index base, rectangular base, or extended base with outboard bearing and tailstock. It can be hand- or motor-operated.

Typical tools that can be sharpened are: dovetail milling cutters, center drills, end forming tools, center reamers, die-sinking tools, step drills, stub reamers, two-flute milling cutters, and other circular tools with evenly spaced flutes.

Circle 575 on Readers' Service Card

Jones & Lamson Economy-Model Comparators

Large-area lenses and generous machine capacity are combined in two direct projection comparators being offered by Jones & Lamson Machine Co., Springfield, Vt. These models are used in a dark or semidark room. Shadow images may be viewed on any suitable flat surface.

Model DPC, Fig. 1, has a single-column support and a measuring capacity of 4 inches vertically and 5 or 8 inches horizontally, depending on the work-table selected. Model DPC-ER, Fig. 2, has double-column support and a measuring capacity of 8 inches vertically and 10 inches horizontally. Both models give full, accurate coverage up to 60 inches in screen size at all magnifications. Standard (FC-30) lenses are provided for magnifications of 5 to 100. Powers above 100 are also available for special applications.

The J&L direct projection comparators are currently in use for the measurement and inspection of a wide range of parts, including gas turbine blades, wind-tunnel aircraft models, hob and milling cutters, templates, and contour-turned parts.

Circle 576 on Readers' Service Card

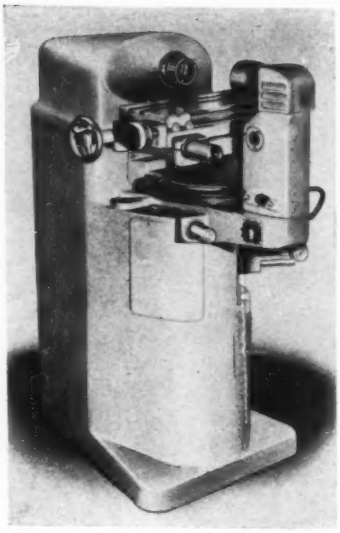


Fig. 1. Optical projector Model DPC announced by Jones & Lamson Machine Co.

Baird Transfer Press for Producing Light-Bulb Socket Screw Shells

Light-bulb socket screw shells are being produced at the rate of 150 per minute on a Model 3-25 transfer press built by the Baird Machine Co., Stratford, Conn. The shells are completely finished, including the rolling of threads, directly from coiled stock. In operation, 2 1/2-inch wide by 0.010-inch thick brass stock is back roll-fed into the transfer press. The stock is fed through the blanking station twice to minimize scrap loss. Scrap chopper action takes place on the second pass of the stock. The first operation on the eight-station die set on 3-inch transfer spacing is blanking, followed by cupping, drawing, piercing, trimming, thread rolling, and, finally, ejection.

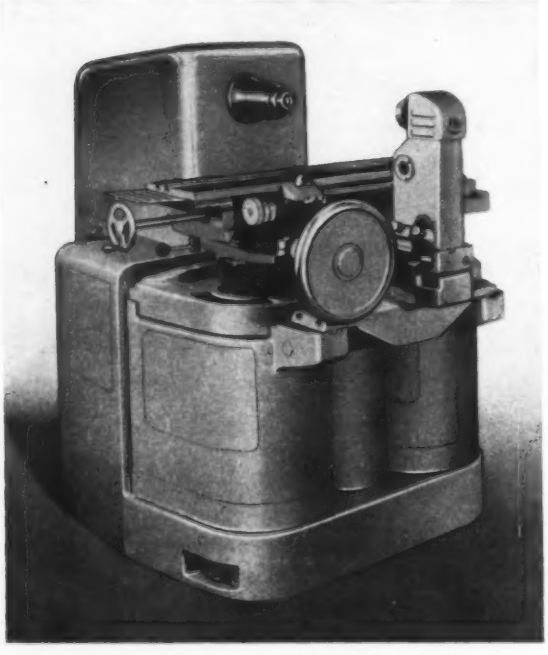
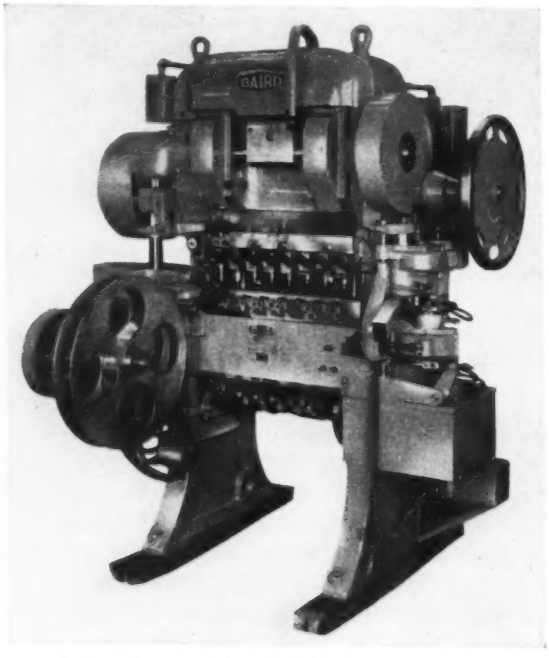


Fig. 2. Jones and Lamson Model DPC-ER optical projector



Eight-station Baird Model 3-25 transfer type press

SHAFT-DIAMETER NOMOGRAPH—1

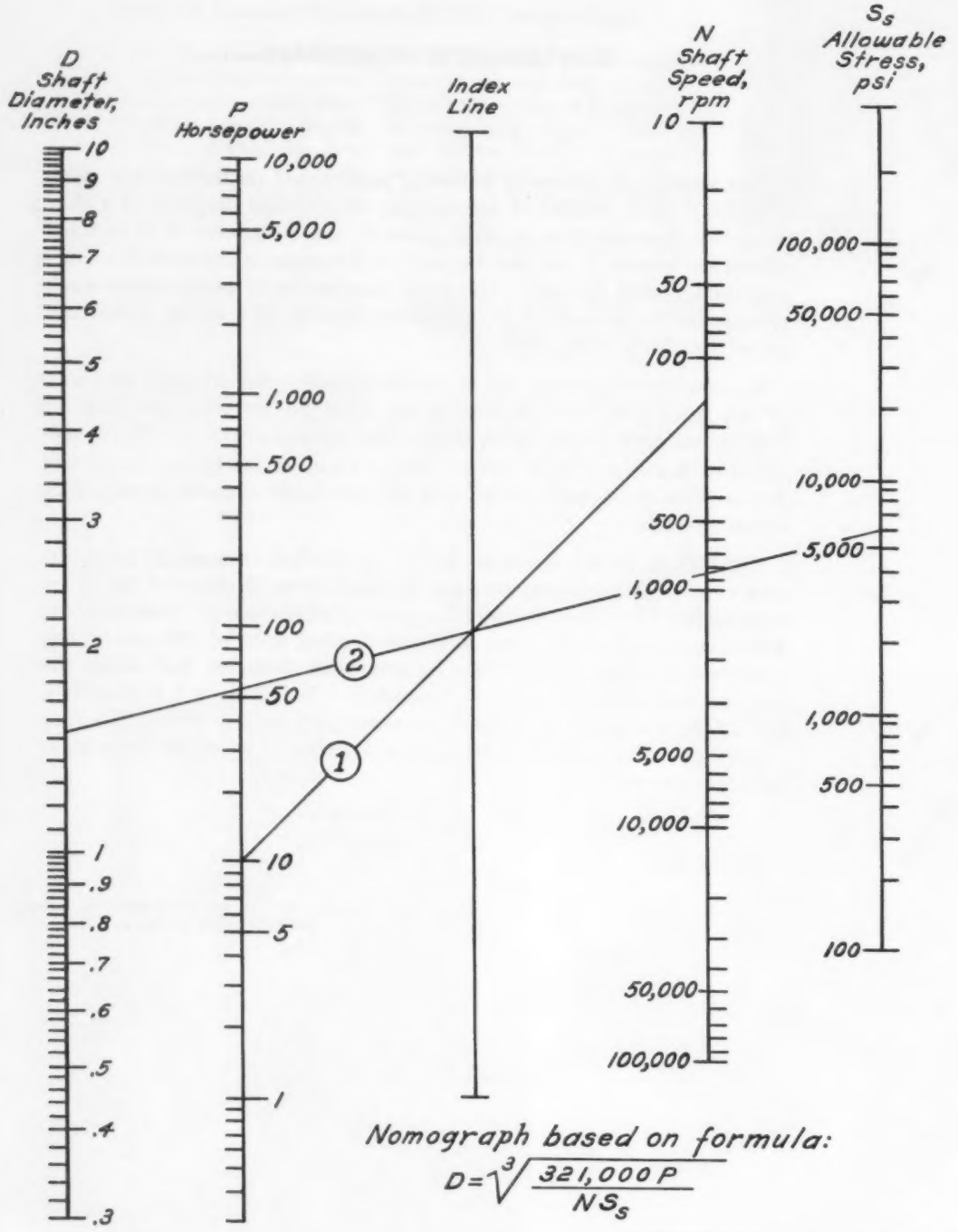
The nomograph shown on following page, based on the formula given, provides a quick method of determining the required diameter of a shaft when the allowable stress S_s, shaft speed N, and horsepower P to be transmitted are known. It can also be used to determine stress limitations of a shaft of specified diameter. The rapid comparison of many values made possible by the nomograph permits the evaluation of a design to be completed accurately and quickly.

In manufacturing plants the allowable stresses generally used are: 4000 psi for main power-transmitting shafts; 6000 psi for lineshafts carrying pulleys; and 8500 psi for small, short shafts, countershafts, etc. Shafts subjected to shocks should be given a greater factor of safety by using lower stresses. This nomograph can be used for other types of shafts having much higher stresses.

EXAMPLE: To find the diameter of a lineshaft to transmit 10 hp at 150 rpm, connect 10 on horsepower line P with 1.50 on shaft-speed line N by drawing line (1). Then, through the point at which line (1) intersects the index line, draw line (2) from point representing stress of 6000 psi on line S_s. Extend this line to line D, representing shaft diameter. This shows the required shaft diameter to be approximately 1.53 inches, or 1 9/16 inches. Using the nomograph in a similar manner permits any one of the four values for D, P, N, and S_s to be quickly determined when the three other values are known.

Nomograph developed by Robert L. Peters, consultant, San Francisco, Calif.

SHAFT-DIAMETER NOMOGRAPH—2



Nomograph based on formula:

$$D = \sqrt[3]{\frac{321{,}000\,P}{NS_s}}$$

Nomograph developed by Robert L. Peters, consultant, San Francisco, Calif.

which drill really costs less?

Based on results, drills "A" and "B" (center and right, above) should cost 43% and 39% less than W & B drills (left, above)—instead, they can be purchased at *only* about 20% less.

Watch those *initial* costs—they may be *costly!*

COMPARATIVE DRILLING PERFORMANCE

General Purpose Jobbers Drills	*No. of holes per drill size					Total No. of Holes	Efficiency Rating
	#40	#30	3/16"	1/4"	3/8"		
W & B Drills	208	62	57	50	34	411	100%
"A" Drills	142	24	14	28	28	236	57%
"B" Drills	114	49	13	61	15	252	61%
Thickness of plate	1/32"	3/16"	1/2"	1"	1"	Material: Heat treated chrome nickel steel	

In each drill size, five drills of each brand were tested and each drill was resharpened three times as required.

W&B

PARTNERS IN PRODUCTION PROGRESS

Many drill performance tests similar to this one have been made. However, W & B will gladly conduct drill tests at *your* plant and under *your* conditions. Contact us direct or through your W & B distributor. He can offer this service plus fast delivery from complete stocks.

WHITMAN & BARNES

40000 PLYMOUTH ROAD • PLYMOUTH, MICHIGAN

DRILLS • REAMERS • END MILLS • COUNTERBORES • COUNTERSINKS • CARBIDE TOOLS • SPECIAL TOOLS

The thread rolling is accomplished by means of a thread-rolling attachment mounted on the right-hand side of the machine and is mechanically timed to coordinate with the cycling of the machine.

The transfer press has a rated machine capacity of 25 tons, with a maximum ram stroke of 3 inches and a maximum transfer stroke of 3 inches. Baird transfer presses are available in four different models ranging from the Model 2-19, with a rated machine capacity of 15 tons, to the Model 5-51, with a rated machine capacity of 75 tons.

Circle 577 on Readers' Service Card

Semiautomatic Grinding and Polishing Machine

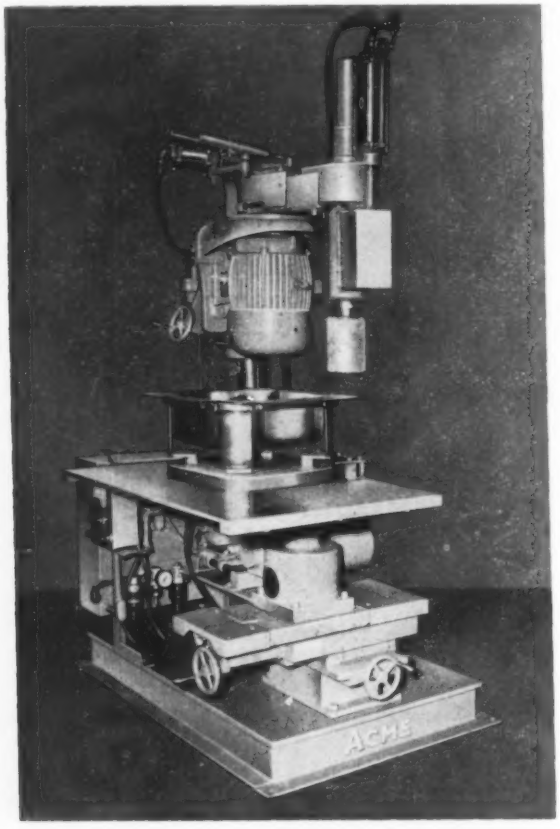
A special semiautomatic machine that automatically grinds and polishes the inner side contours of stainless-steel sink bowls and similar work is now available from the Acme Mfg. Co., Detroit, Mich. The machine basically consists of an adjustable retracting spindle unit with abrasive polishing wheel and a roller feed unit mounted on a common base.

In operation, the work to be polished is placed in the fixture on the machine table. When the start button is pressed, the automatic polishing cycle begins. The work-table is automatically moved from the loading position to the polishing position by a timer-controlled air cylinder. A second air cylinder automatically actuates and lowers the abrasive wheel into the inside of the work. A third air cylinder positions the wheel against the side of the work.

The work-fixture is mounted on a gear chuck which is pinion-driven by a variable-speed worm-gear drive. The shape of the gear chuck conforms to the inside contour of the work so that close contact is maintained between the sides being finished and abrasive wheel. A spring tension permits the wheel to float and maintain uniform pressure during the polishing operation.

At the end of a predetermined automatic finishing cycle the timer-controlled air cylinder removes the wheel from contact with the work, the wheel retracts to the upper position, and the fixture automatically stops rotating and returns to the unloading position. Work-pieces or sinks of various sizes can be polished through the use of separate interchangeable fixtures.

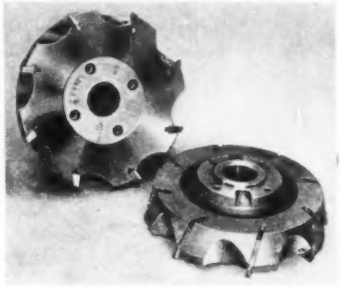
Circle 578 on Readers' Service Card



Acme semiautomatic polishing machine for finishing inner surfaces of stainless-steel part

Milling Cutter that Pumps Coolant from Its Reservoir for High-Speed Cutting

A special Rigidcut inserted-blade face mill which rough-mills a 7-inch long aluminum automobile part in nine seconds has been designed by the Wesson Corporation, Ferndale, Mich. Surface flatness is held under 0.0005-inch maximum indicator reading and surface finish well below 100 micro-inches. In addition, the cutter uses centrifugal force to deliver coolant where it is needed.



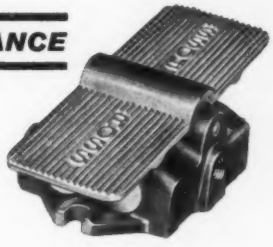
Wesson special Rigidcut high-speed milling cutter

The cutting speed of this 8.24-inch diameter cutter is 7776 sfpm with a feed rate of 158 ipm. The eight inserted blades are tipped with Wessonmetal Grade GI carbide. The cutter is mounted on a motorized spindle, rotating at 3600 rpm. The spindle has high

The world's largest line of air valves is also the most advanced because of the Ross engineering staff

Do you know these Ross air controls?

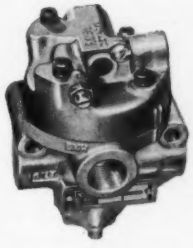
EASY MAINTENANCE



Rugged, dependable foot valve

The 600 valve series. Features maintenance without disconnecting piping, rugged construction and a variety of treadle options: double or single treadle; spring return or detent. Also available as a hand valve. 3-Way and 4-Way models, ¼".

AIR AUTOMATION



Time delay sequencing valves

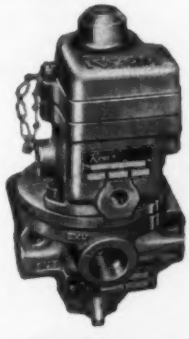
The Ross Graymodel Valve is actuated by pilot air from another part of the circuit. Times in with cartridge in one position, times out if cartridge is reversed. Adjustable to 0 to 3 second delay.

RUGGED

More Comfort for Machine Operator

Push buttons may lead to sore fingers but not this palm button valve. 2⅞" button is comfortably convex. Valve is ruggedly built, available with or without key-locking feature. Red or green button, flange mounting. S-Way or 3-Way.

ECONOMY



Small valve does bigger valves work

The Pacer Headline Valve gives you highest capacity valve-size for valve-size of any solenoid valve on the market. Capable of rapid cycling, consumes little power. S-Way, 3-Way and 4-Way models. ¼" through 1½" pipe sizes.

For more information write us, or contact your nearby Ross representative. See our digest catalog in Sweet's

THE WORLD'S MOST COMPLETE LINE OF AIR CONTROL VALVES. AVAILABLE ALL OVER THE FREE WORLD.

Ross OPERATING VALVE COMPANY

110 E. GOLDEN GATE • DETROIT, MICHIGAN

rigidity and no backlash, which is important because the roughing stock or cut varies from 0.015 to 0.060 inch.

If coolant were directed from outside the cutter, it might be "blown" away from the cutting edges. In the special body design, a groove (see illustration) in the back face of the cutter acts as a reservoir and centrifugal-force "pumps" the coolant through 1/4-inch radial holes to the blades.

The blades are wedge-shaped, so that centrifugal force tends to drive them tighter into their slots for maximum safety. The cutter operates within a welded shield, however, to confine the coolant—so that if a blade did break, no hazard would be incurred. Approximately 11,000 parts are produced per grind and, with seventeen grinds, about 175,000 parts are made per set of blades. It takes about five minutes to change cutters. Setup costs are kept down through the use of an adapter which enables the whole cutter to be set forward to maintain the required accuracy. Including initial cost of the blades and cutter grinding costs, tool cost is said to be only 47 cents per thousand parts.

Circle 579 on Readers' Service Card

Card-Programmed Circuit Tester

A random access, card-programmed automatic circuit tester with an unlimited growth capacity has been developed by the Hughes Aircraft Co., El Segundo Division, Los Angeles, Calif. This tester was shown for the first time at Wescon in San Francisco, Calif., August 22 to 25. Called FACT-RC, the tester is the second in the Hughes line of flexible automatic circuit testers used for checking wiring harnesses and electrical assemblies for current continuity and high potential. It is now in use at the company's ground systems group at Fullerton, Calif.

FACT-RC tests are controlled by programmed IBM cards corresponding to a unit's individual circuit-test requirements. One card is required for each circuit, and the machine processes seventy-two cards a minute. Circuit faults are noted by type and location on a print-out tape, and by the cards as they fall into "condition of circuit" bins. Complete tests can be computer-programmed if the unit under test has been built using IBM wiring or signal code lists.

Accessories include a digital ohmeter and an auxiliary power panel. The ohmeter measures the resistance between any "from" and "to" points, and the results are printed on the output tape. With the power panel, FACT-RC can supply voltages to a wire under test for operation of devices such as relays, lights, and blowers. Any number of relays can be operated sequentially or simultaneously in the unit under test. The wire to which the output power is supplied can be selected by a programmed IBM card. The basic FACT-RC unit has a capacity of 1200 wire terminations. Building-block modules can be added in 1200 termination increments to increase capacity as required.

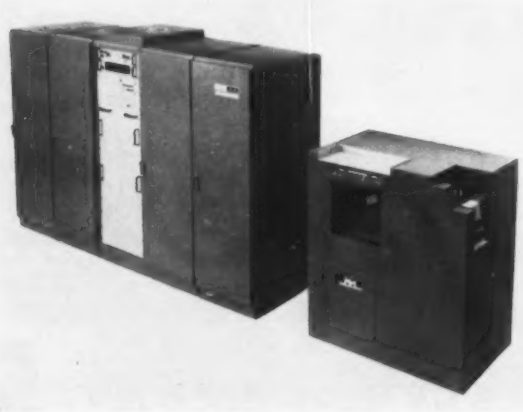
Circle 580 on Readers' Service Card

Improved Model Fly-Tool Cutter Holders

The City Tool-Die & Mfg. Co., Inc., San Jose, Calif., has announced an improved model of its "Fli-Kut" fly-tool cutter holders. This new holder is counterbalanced to permit faster speeds, faster feeds, and finer finishes than preceding models. It is furnished in sets of three different-sized holders with a plastic stand.

Using 5/16-inch carbide or high-speed tool bits, Fli-Kut holders are especially adapted for rapid stock removal and smooth finishing of surfaces up to 6 inches wide in one cut. The 3/4-inch shank of the holders makes them adaptable to most vertical mills. The holders are made of steel and hardened to give long rugged service.

Circle 581 on Readers' Service Card



Circuit tester developed by Hughes Aircraft Co.

Set of three Fli-Kut fly-tool cutter holders

Outstanding Performance...

CINCINNATI

CUSTOM GEARS AND GEAR BOXES are *outstanding performers* — the result of old-fashion craftsmanship applied to latest techniques and machines for gear making and inspection.

Ask for this brochure—CINCINNATI custom gears are made in all types to 72″ diameter cut teeth, 39″ shaved teeth, 25″ ground teeth.

better still . . . Send us your prints for quotation

CINTI®

THE CINCINNATI GEAR CO.

Cincinnati 27, Ohio

Custom Gear Makers Since 1907 GEARS, good gears only

For more data, circle this page number on Readers' Service Card

Tape-Controlled Machine for Drilling Printed Circuit Boards

A machine designed to drill printed circuit boards of a wide variety of materials and thicknesses at low cost has been developed by the Edlund Machinery Co., Cortland, N. Y. This programmed driller consists of a tape-controlled point-positioning table and four drilling clusters, each with four independent air-feed drill units. Under average conditions, the driller operates at 50 cycles per minute and drills four boards at once, resulting in 200 holes per minute. If boards are stacked four deep, sixteen can be drilled at once.

The versatility of the machine permits rapid changes in drill size and speed. Each cluster consists of four independent units which may be fitted with different-size drills up to 1/8 inch and rotated at different speeds up to 22,000 rpm. Since these are tape-controlled, the changes are automatic, eliminating slow manual retooling. Additions or deletions to the tape can usually be made in a matter of minutes, providing for a quick and inexpensive "tooling up" job.

The tape-controlled point-positioning table has a travel of 14 by 20 inches at 200 ipm and a flat working surface of 18 by 44 inches. It is built with a 2-inch zero offset in each axis, allowing the table movement needed for changing to different drill sizes. A special rapid backlash-setting device provides for rapid table positioning.

The maximum drilling pattern varies according to the number and size of the drills being used. With two sizes of drills in each of two clusters, the maximum pattern is 14 by 18 or 12 by 20 inches; with four sizes of drills in each of four clusters, the maximum pattern is 10 by 12 inches.

The machine was designed for use with a General Electric Mark II numerical positioning control having buffer storage and fast reading. However, it is also available with a standard Mark II control without the buffer storage. A tape programmer, Model TPR, is also available for use with the machine. This completely independent unit prepares conventional 1-inch wide, eight-channel tape directly from art work, locating up to thirty positions per minute easily and accurately. It is extremely versatile, handling grid sizes down to 0.025 inch, including unusual sizes such as 0.14 inch and grids that vary from the X to Y axis.

Circle 582 on Readers' Service Card

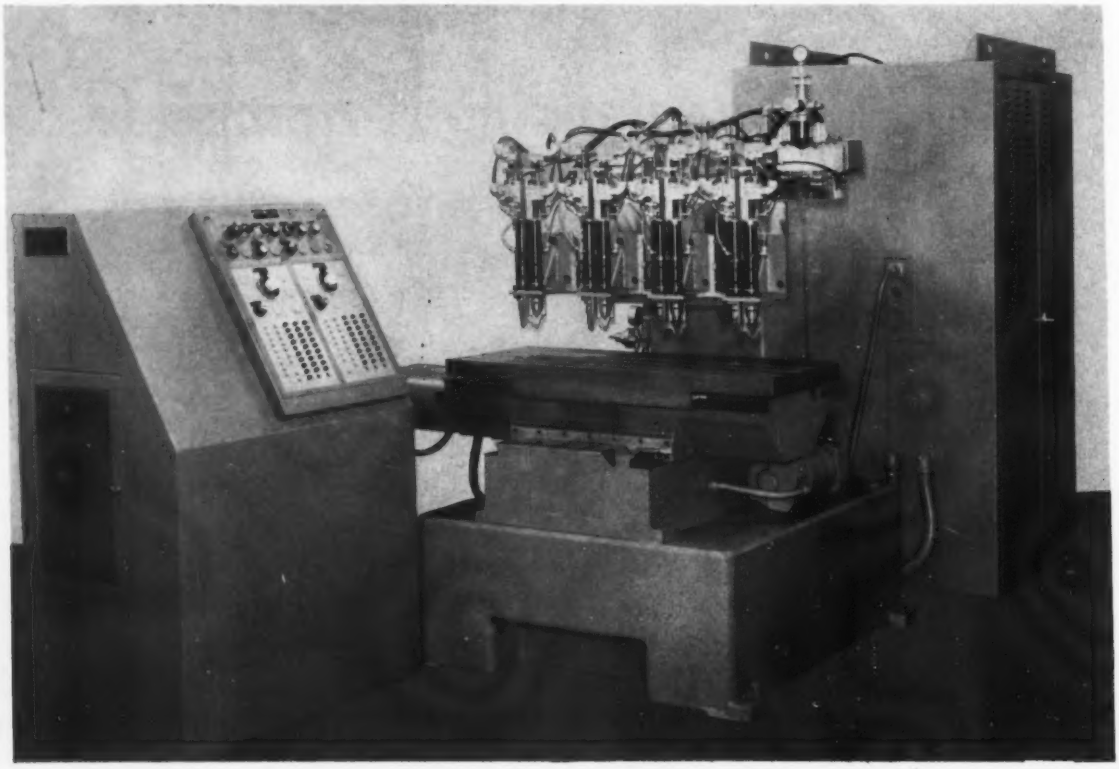
Adjustable Manual Air Gages

The Standard Gage Co., Inc., Poughkeepsie, N. Y., has announced a complete selection of adjustable manual air gages. Designs which have been proved in actual use for as many as twenty years are now adapted to air. They include Standard's bore gages, available in seven sets to cover inside diameters from 0.123 to 24 inches, and twelve adjustable Airsnaps to cover all outside diameters from 0 to 12 inches.

Other adjustable manual gages cover such types as shallow diameter gages, pitch diameter comparators, and regular bench type comparators—in fact, any indicating type gage regularly manufactured by the company.

Circle 583 on Readers' Service Card

Edlund printed circuit-board drilling machine numerically controlled by G-E buffer-storage Mark II system



AT ROBERTS PRECISION PARTS, INC.

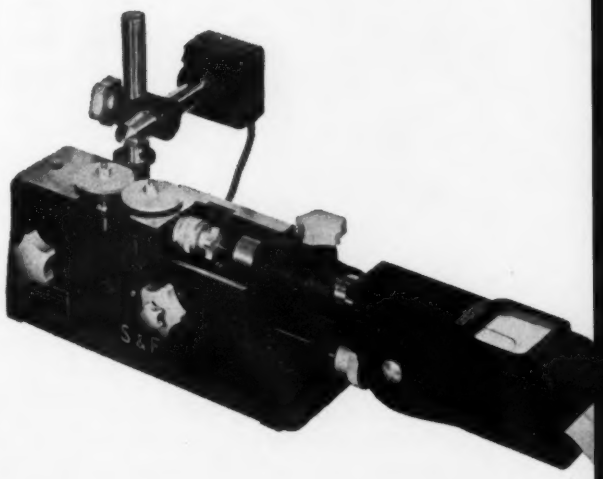
a quality #14 gear isn't considered accurate until an S&F tester proves it

These precise spur gear and bevel gear differentials are destined for important missile and guidance system assignments. Roberts Precision Parts, Inc. makes them as a matter of course in its Woodside, N. Y. plant.

But they don't take manufacturing accuracy for granted. Nor do they trust ordinary gear checking methods. Every gear—whether it be ⅛" or 6", bevel, spur, worm or helical—*must* be cleared during production and final inspection on an S & F Gear Tester to confirm that total composite error does not exceed .00027"; maximum tooth-to-tooth error is within .00014". Robert J. Schmeidel, president, explains it this way: "It would be impossible to check such precision gears properly without our six S & F Testers. As a doctor depends on his stethoscope, we depend on an S & F to show us the defects in any gear."

So do hundreds of gear makers—and users—who take precision gear performance seriously enough to check *every* gear by only the most accurate method available—the S & F. (Guaranteed to repeat within .00001".)

Why don't you test the gears you make—or buy—on the S & F? It's the one way you can be sure that they are as accurate as they're supposed to be. Ask us to demonstrate it for you.



KURT ORBAN
COMPANY, INC.
1259 U.S. Route 46, Parsippany, N.J.

Dial Type Machine Combines Assembly, Sizing, and Inspection

The Bodine Corporation, Bridgeport, Conn., has built a dial type machine tooled to perform the assembly, sizing, and inspection operations on an automotive valve. On the first pass, the part is nested in a vertical position, and a bronze bushing is hopper-fed into the valve and inserted by the machine slide. A sizing ball is pushed through the bushing, and the inside diameter of the bushing is then checked with a Pratt & Whitney air gage for size. The air unit seen on the upper left of the machine shows the operator how the hole size is running.

On the second pass the part is removed from the nest fixture and placed over the mandrel fixture while a new part is inserted in the nest. On this pass a check valve is assembled. A steel ball is hopper-fed into the valve body. At the next station, a coil spring is wound on a Torrington Springwinder and blown into place. The Springwinder is cycled to the machine and produces a spring only on demand. Next the part is inspected for the presence of the check ball and spring, and a roll pin is hopper-fed and inserted. The completed part is then removed from the dial. The alternate station dial permits two operational sequences to be performed at the same time. One part is completed at each stroke of the machine.

The venturi-operated sizing ball return unit is extremely simple. As a ball is pushed through the bushing it falls into a funnel-mouthed tube. A venturi tube causes the ball to blow back to the inserting station. The "Check-Light" panel shown on the upper right of the machine indicates the source of any malfunction, such as improperly seated parts or lack of an assembly component.

Circle 584 on Readers' Service Card

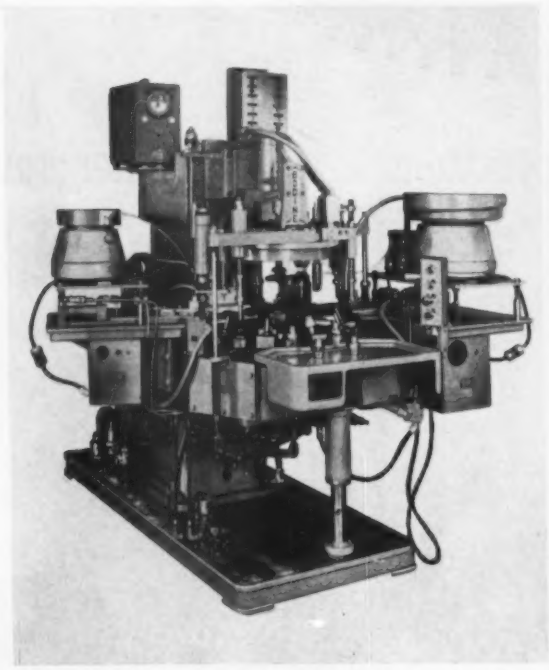
Electronic Gage for Aligning Holes with Machine Spindles

A highly sensitive and accurate electronic gage for conveniently centering holes or cylindrical forms under various types of machine spindles is announced by the Federal Products Corporation, Providence, R. I. Several magnifications are available, the highest being 5500 to 1 with 0.000020-inch graduations. It has a three-scale meter. Other uses of this gage are checking spindle runout and exploring for taper, bell-mouth, squareness, roundness, concentricity, etc.

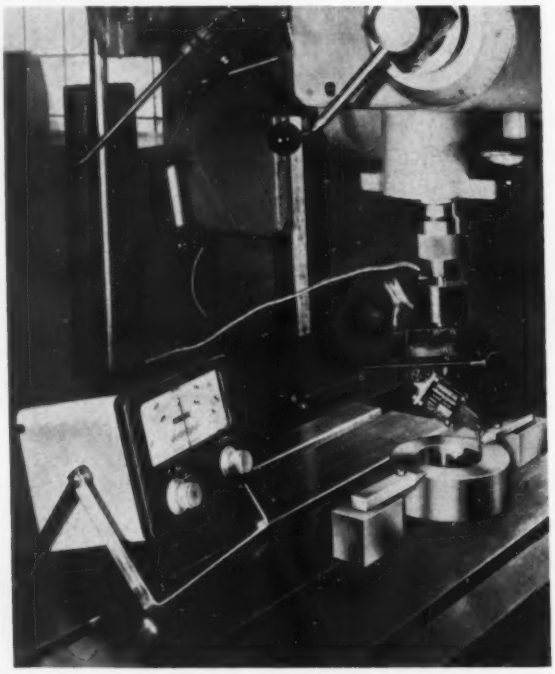
A rotary connector allows the gage head to rotate freely with the spindle while the cable to the amplifier remains stationary. The connector is adjustable to accommodate radii up to 9 1/2 inches, and has a mechanical fine adjustment to increase ease of setting. Gaging pressure of less than 2 1/2 grams eliminates deflection of the spindle.

The amplifier is transistorized and battery-powered. Its small size and self-contained power source greatly simplify its use. The amplifier and gage head can be used separately for other gaging applications.

Circle 585 on Readers' Service Card



Bodine dial type machine that combines assembly, sizing, and inspection operations



Federal electronic center-finder gage designed for aligning work with machine spindles

COMPANY, INC.
1259 U.S. Route 46, Parsippany, N.J.

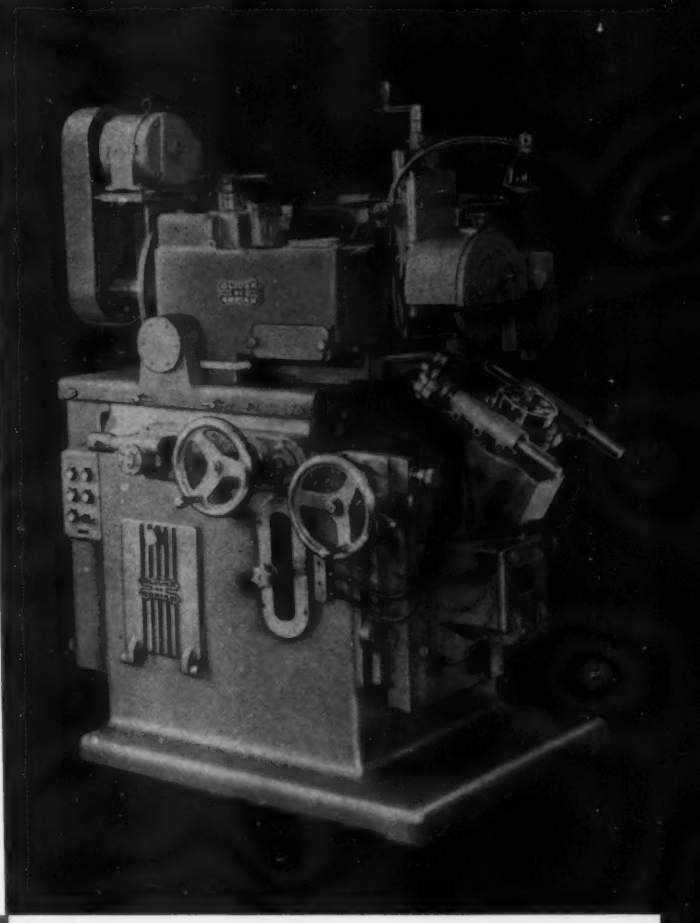
NEW FOR 1961

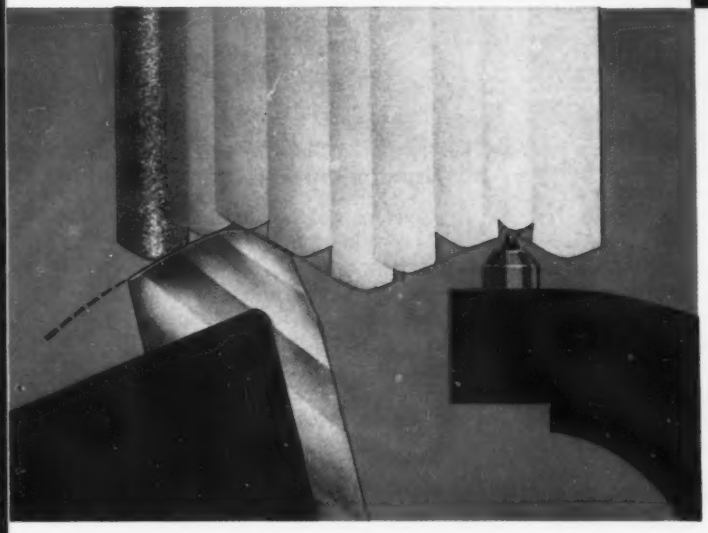
OLIVER OF ADRIAN MODEL 624 FACE MILL GRINDER

More versatile—greater capacity—loaded with new features. These are the advantages of the new Oliver Model 624 Face Mill Grinder for 1961.

The new design permits the grinding of the periphery of the face mill when it is approximately 90° from the face of the cutter. Any intermediate angles or unusual forms can be obtained. It is now possible to grind the periphery, lead angle, corner radius, face, dish or any combination because of the new design. Too, the basic range has been extended to handle face mills from 6″ to 24″ diameters.

Most important though is that all of the many advantages of "going Oliver" have been retained. Peak performance in face mill operations is obtained because Oliver assures maximum cutter life, extreme accuracy, and rapid sharpening.





Wheel dressed with every stroke

The drawing above shows the grinding wheel passing over a cutter tooth after being dressed and formed automatically by a fixed diamond. This happens with every stroke. Automatic feed-down accurately compensates for grinding wheel wear, providing a fixed grinding line with a minimum of run-out.

The face mill is automatically indexed and the tooth shape controlled by a simple cam arrangement. Any practical roughing or finishing form can be obtained.

Smooth and fast—accurate and trouble free

New and old features combine to make the Oliver Model 624 Automatic Face Mill Grinder one of the most efficient machines in the shop. For example:

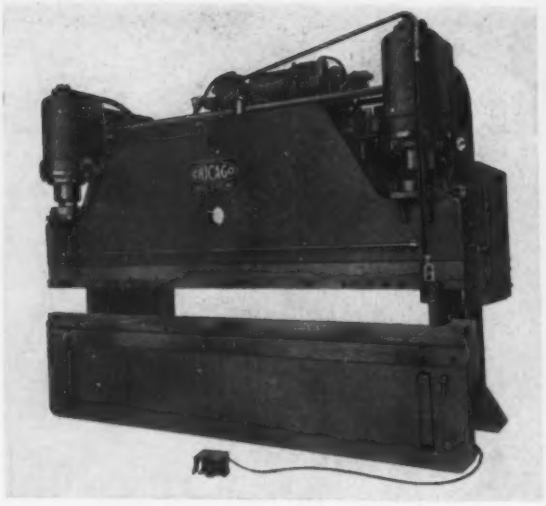
- The machine is faster and smoother, hydraulically operated with speeds from 4 to 8 times faster than competitive manual machines.
- Hydraulic ram lifter permits easier change of cams.
- Cam surfaces are automatically lubricated.
- Better finish is provided on the cutter teeth by an automatic slow up on the clean-up pass.

Oliver also produces a manually operated, heavy-duty face mill grinder and an arc radius cutter grinder for face mills and cutters requiring a corner radius.

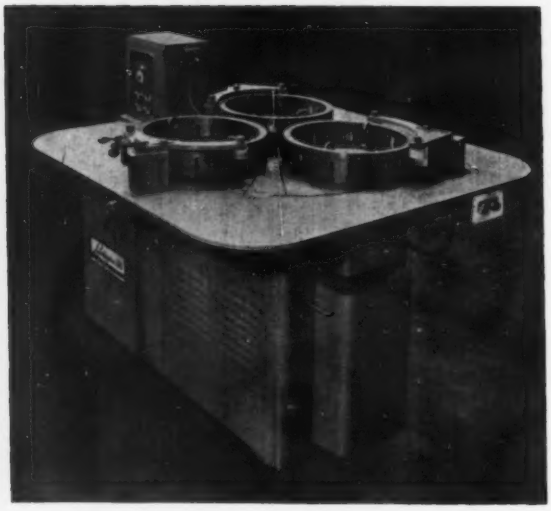
To demonstrate the ability of the machines, Oliver will grind face mills on a "no charge" basis. Write for full information and be sure to let Oliver quote.

OLIVER of ADRIAN
1410 E. Maumee St. • Adrian, Michigan

DRILL GRINDERS AND THINNERS—AUTOMATIC AND MANUAL FACE MILL GRINDERS—TOOL AND CUTTER GRINDERS—TOOL BIT GRINDERS—CONTOUR SAWING AND FILING MACHINES.



Chicago hydraulic press brake of 200-ton capacity, one of new line introduced by Dreis & Krump Mfg. Co.



Model 36 Lapmaster, recently redesigned and improved, announced by Lapmaster Division of Crane Packing Co.

Hydraulic Press Brakes

The Dreis & Krump Mfg. Co., Chicago, Ill., has announced a new line of "Chicago" hydraulic press brakes with many exclusive features designed for simple, accurate control and operator convenience. These machines are offered in forty-two standard sizes from 100- to 1000-ton capacity. For capacities from 1000 to 2000 tons the specifications are developed to suit individual requirements of the user.

Some of the new features on the Chicago hydraulic press brakes are: proved, precision-built, variable-delivery Oilgear pumps with simplified valve and piping circuit; ultrafine electronic sensing for precision ram-leveling control; compact panel with low-voltage control; infinitely variable ram speeds within the specification limits; and zero positioning.

Circle 586 on Readers' Service Card

Redesigned Lapmaster

A new Model 36 Lapmaster has been introduced by the Lapmaster Division of Crane Packing Co., Morton Grove, Ill. The machine, which is essentially a completely redesigned version of the present 36-inch Lapmaster, is said to offer a new concept in production lapping efficiency. Among the new features is an abrasive distribution system which maintains the correct mixture of compound to vehicle from initial filling to the last drop. Pressure pumping at a constant head assures uniform deposit at the lapping stations. It also provides an adjustable flow control to obtain maximum stock removal. The pump and tank are mounted on the inside of the door in the machine base which swings out for filling ease, but is out of the way during production.

This compact Lapmaster has been designed to provide the ultimate work efficiency within the smallest possible floor area. The large, wrap-around adjustable work-table that may be raised or lowered to be in the same plane with the lap plate and a remote start and stop station permit easier loading and unloading of parts from almost any position. A conveniently located main control column includes automatic timer for presetting the lapping cycle. A hand screw is provided for easy adjustment of the conditioning ring to compensate for normal wear patterns in the lapping plate.

The Model 36 Lapmaster, equipped with either three or four conditioning rings, is also available with pneumatic lifts to facilitate raising and lowering of conditioning rings and/or pressure-plates. As with all Lapmasters, the new models will lap parts of almost any shape, form, or material on a production basis within tolerances of one light band or less and uniform microinch finishes of 2 to 3.

Circle 587 on Readers' Service Card

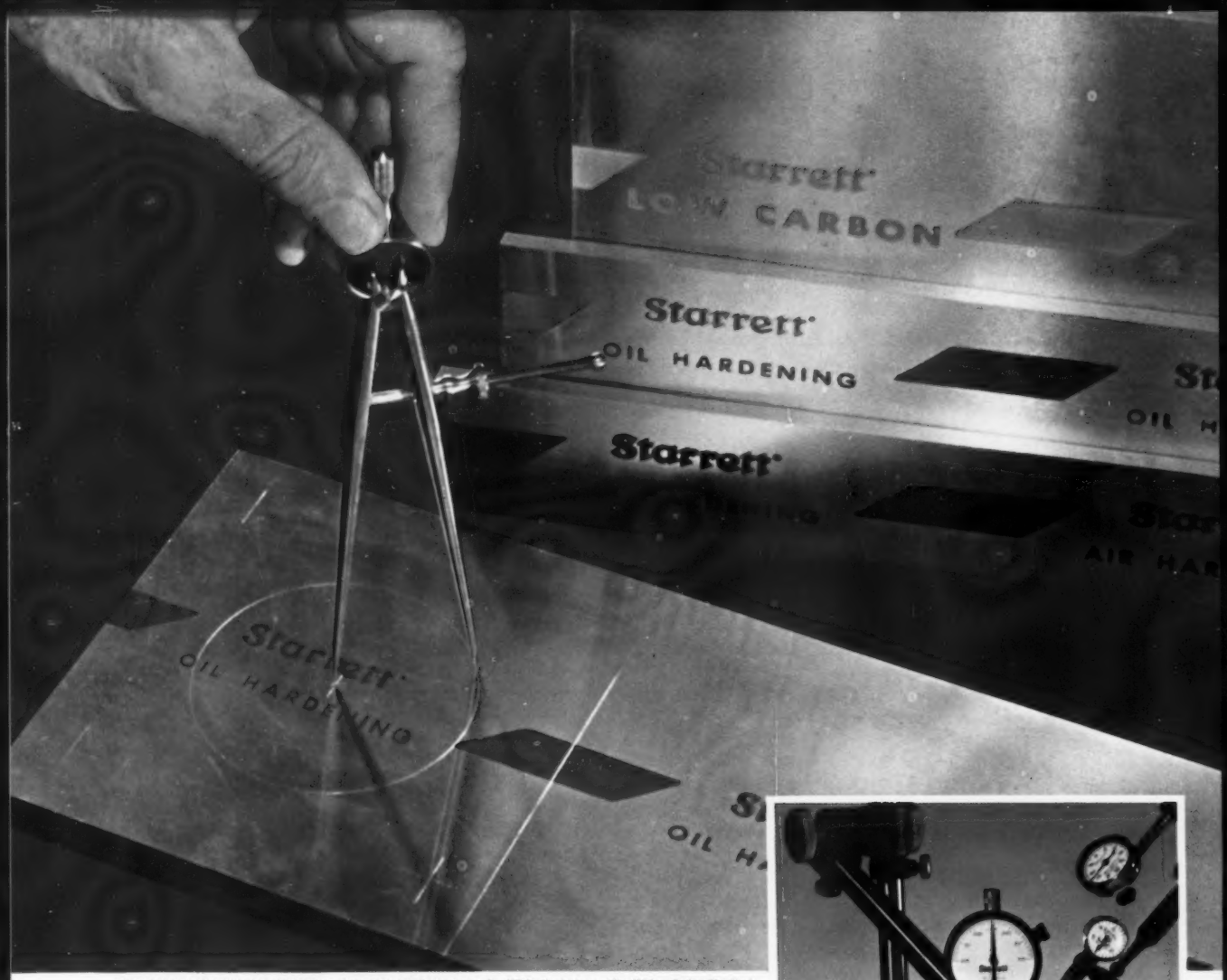
Airco Valveless Torch for Continuous Welding and Brazing Operations

A valveless welding torch suitable for production welding and brazing operations has been made available by Air Reduction Sales Co., a division of Air Reduction Co., Inc., New York City. Greater economy in gas consumption and reduced operator fatigue are said to result from a centralized control system adapted to the Airco Style 725 valveless welding torch. Specifically, the new unit differs from other standard dual-hose welding torches in that needle valves have been eliminated from the torch assembly.

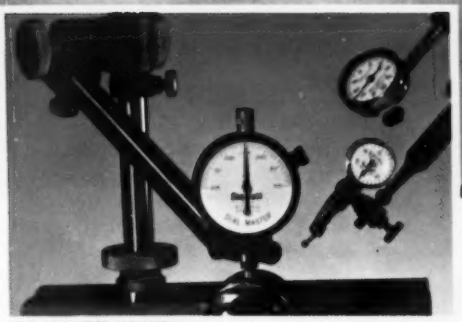
A gas mizer is used in conjunction with the modified torch. Flame adjustment is made at the regulators on the gas cylinder or pipeline station. The gas mizer, located between the gas supply and the torch, closes off the fuel mixture whenever the torch is hung on the hanger-arm hook. When

be obtained.

FACE MILL GRINDERS—TOOL AND CUTTER GRINDERS—TOOL BIT GRINDERS—CONTOUR SAWING AND FILING MACHINES.



PRECISION GROUND DIE AND FLAT STOCK — Starrett No. 496 Oil Hardening, No. 497 Air Hardening and No. 498 Low Carbon Flat Stock.



DIAL INDICATORS AND GAGES

HACKSAWS, HOLE SAWS, BAND SAWS, BAND KNIVES

PRECISION TOOLS.

every inch identified as Starrett® quality and precision

There's no mistaking the quality and precision of Starrett flat stock and die stock . . . each piece is made to exacting Starrett metalurgical specifications and precision ground to Starrett standards of dimensional accuracy.

And there's no mistaking the *type* of steel because each piece is clearly identified by *color* and *name* over the full length. Available in a wide range of sizes in air, oil and water hardening tool and die steel types and in free machining-low carbon flat stock. Individually packaged in distinctive, rust-inhibiting, protective envelopes.

Your nearby Industrial Supply Distributor is your best source for prompt delivery, dependable service and quality products. Call him or write for Catalog No. 27 showing the complete Starrett line. The L. S. Starrett Company, Athol, Massachusetts, U. S. A.

World's Greatest Toolmakers

the torch is picked up, the flow of gas is started again. The gas mizer, which can be equipped with or without needle valves, has a pilot light to ignite the torch.

Adaptability of the Airco 725 torch to mass operations is further enhanced by its light, well-balanced construction, which reduces operator fatigue. This rugged, dependable unit has a gas capacity beyond that normally found in a medium-sized torch.

Circle 588 on Readers' Service Card

Optical High-Precision Angle Checker and Calibrator

By combining a plane mirror and a miniature Ultradex indexing table, the AA Gage Co., Detroit, Mich., has developed the 360-sided "Optic-Mechanical Polygon" for checking or calibrating angles. This instrument, Fig. 1, is guaranteed by the manufacturer to be accurate to 1/4 second of arc, total accumulated error.

The base is made up of two plates, each with 360 serrations, that are separated when the operating handle is depressed. The top plate can then be moved through any angle and lowered onto the bottom plate. Regardless of what degree of angle is being checked, all 360 serrations engage. This patented principle allows the serrations to seat uniformly so that the instrument maintains its accuracy through use.

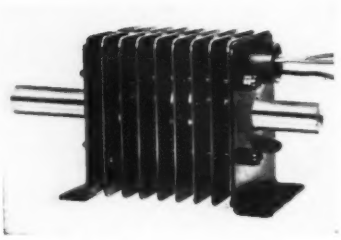
In a typical setup, an auto-collimator is directed to sight on a reference mirror and on the mirror of the Optic-Mechanical Polygon, which is clamped on the dividing head to be checked. The dividing head is rotated a specific number of degrees in one direction, and the Polygon mirror is rotated the same number of degrees in the opposite direction. The amount by which the Polygon mirror does not return to its zero position is determined by sighting through the auto-collimator and is a measure of the inaccuracy of the dividing head.

In the setup, Fig. 2, a gage-block on the Polygon base and a "millionth" electronic measuring instrument are used as a double check. This double check is not used in normal practice. In addition to using the Optic-Mechanical Polygon in the above manner, multiple lines of sight can be established, using two or more auto-collimators, so that angular products can be checked without differential rotation. The diameter of the clamping ring is 5 inches.

Circle 589 on Readers' Service Card

Skinner Polynoid Linear Actuator

An electromechanical linear actuator which utilizes electrical induction principles to deliver a uniform long stroke has been announced by Skinner Precision Industries, Inc., New Britain, Conn. This Polynoid linear actuator is designed to meet a wide range of requirements. Six models featuring different stroke lengths and output forces are available from stock for testing, evaluation, and prototype use. These models operate on standard alternating-current voltage and come furnished for foot mounting. They are designed to provide reliable and easily controlled motion at low installed cost.



Polynoid linear actuator announced by Skinner Precision Industries, Inc.

The actuator contains only one moving part—the rod—and can be used to hold a load at any position or to provide reciprocating motion. The stroke is up to 6 inches with standard units and is virtually unlimited in specially engineered units. The actuator produces uniform output force throughout its stroke in either direction which is directly proportional to the input power.

Circle 590 on Readers' Service Card

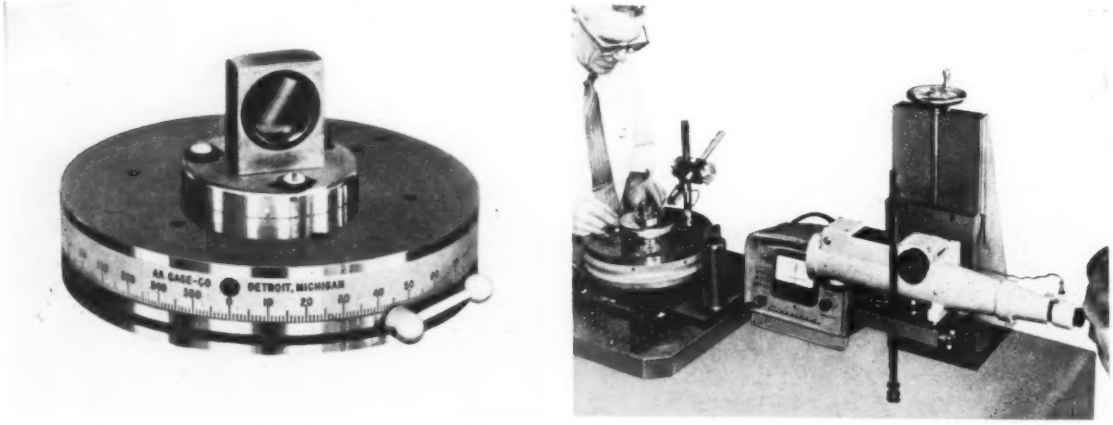
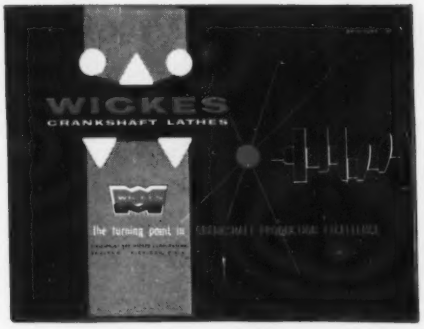
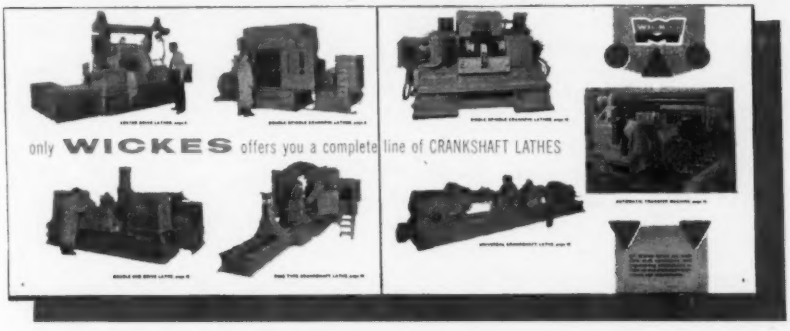


Fig. 1. (Left) Optic-Mechanical Polygon for accurately checking or calibrating angles developed by the AA Gage Co. Fig. 2. (Right) Auto-collimator being used to check accuracy by sighting through mirrors to the 360-sided Optic-Mechanical Polygon angle-measuring instrument located on top of the dividing head



IT TOOK WICKESmanship

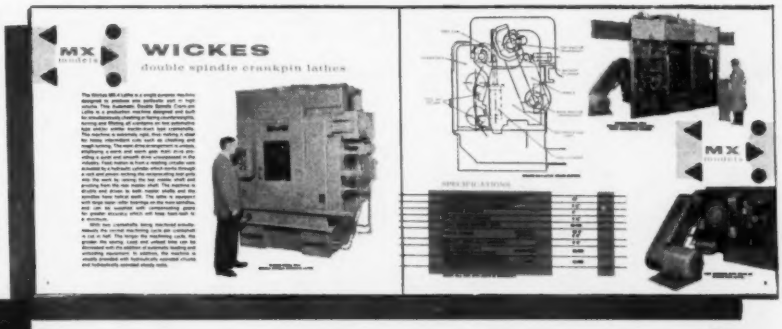
to write the book on CRANKSHAFT LATHES



WICKES MACHINE TOOL... builders of the world's only complete line of Crankshaft Lathes, now brings to the engine industry the newest and most complete Crankshaft Lathe catalog.

The two best reasons in the world for writing a book on Crankshaft Lathes are *need* and *lack*. Experts in the field of manufacturing engines need such a catalog—and WICKES MACHINE TOOL recognized the lack of a graphic, detailed Crankshaft Lathe book. WICKESmanship wrote the book on Crankshaft Lathes for both reasons. Here, for the first time, is a complete documentary on the story of the world's first production type Crankshaft Lathe . . . details on the development of the world's first Center Drive Crankshaft Lathe . . . and the full story of the automated efficiency of the WICKES Transfer Machines, Double Spindle Lathes and Center Drive Lathes.

There is no single source published with so much scope and diversification in the entire field of Crankshaft Lathe turning. A FREE copy of the WICKES Crankshaft Lathe catalog is reserved for you. It belongs on your desk. Join with others in the engine industry who already understand the meaning of WICKESmanship . . . the turning point in CRANKSHAFT PRODUCTION EXCELLENCE.



WICKES
MACHINE TOOL
515 N. WASHINGTON AVE.
SAGINAW, MICHIGAN
PHONE PLeasant 7-0411

Write today for your free copy of the WICKES CRANKSHAFT LATHE BROCHURE—261, WICKES MACHINE TOOL, Division of the WICKES CORPORATION, Saginaw, Michigan Dept. A-1

DIVISION OF THE WICKES CORPORATION

world's only specialist in CRANKSHAFT TURNING

For more data, circle this page number on Readers' Service Card

Hydraulic Motor with 30,000,000-to-1 Speed Range Incorporated in Steel Spar Mill

A hydraulic motor, called the Acradrive/22, originally developed by the Cimtrol Division of Cincinnati Milling Machine Co., Cincinnati, Ohio, as a positioning drive for its machine tools, appears to be the solution of a wide variety of power and motion transmission problems. Already this motor is being used to control sophisticated antenna arrangements. Its most extensive use to date, however, is as a positioning motor on precision machine tools. A typical installation consists of three of the motors for obtaining longitudinal movement of the table and transverse and vertical movements of the spindle-carrier on a numerically controlled Cincinnati bridge type profile- and contour-milling machine. The motor has also been used in many Cincinnati special machines. Four of the motors, like the one shown in Fig. 1, are used to control motions in four axes on the special Cincinnati steel spar-milling machine, Fig. 2. The motor is also used on the Heald Machine Co.'s Model S Borematic equipped with Acramatic numerical control.

Among the useful properties of this 22-cubic-inch hydraulic motor is a controlled speed range of 30,000,000 to 1—from 500 rpm to 1/60,000 rpm. Thus the equivalent of one revolution every forty-one and one-half days can be obtained without gearing. The motor has no backlash and a fantastically high response rate: From operation at 100 rpm it will stop, reverse direction, and accelerate to 100 rpm again, all in 0.0015 second. (The blink of an eye takes ten times as long.)

When the motor receives a "stop" signal while turning at 100 rpm, it will rotate just 0.0006 revolution farther before coming quietly to a halt. That is roughly equivalent to 1 inch of movement at the end of a 100-yard radius. This combination of high torque, low inertia, quick response, and stiffness adapts the motor for controlling the orientation of large and precise instruments such as a satellite tracking antennae. Other future possible uses are in such fields as optical maser aiming, navigation, chemical process control, or missile guidance.

Fig. 1. Acradrive/22 hydraulic motor designed for built-in drives by Cincinnati Milling Machine Co.

The complete motor weighs 138 pounds and measures 12 1/2 by 6 inches deep. Although it can be used as a free motor, the design

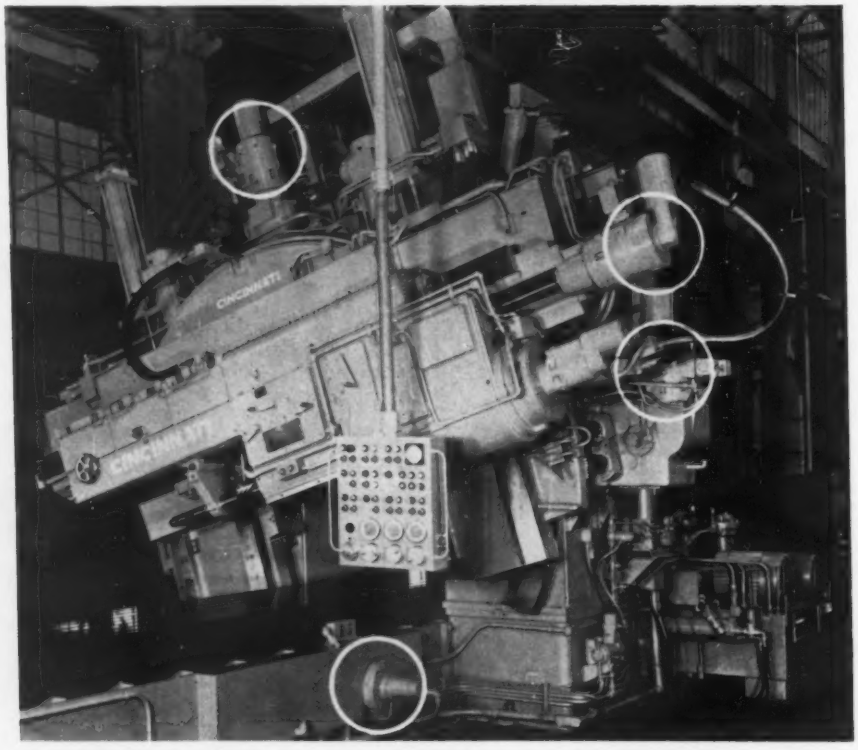
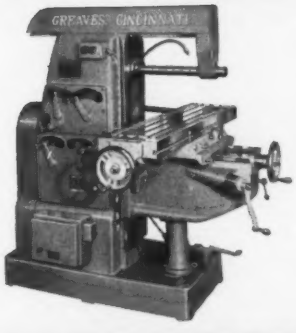


Fig. 2. Cincinnati steel spar mill developed for the aircraft industry. The four Acradrive/22 motors (in circles) control motions in four axes

NOW...GREAVES SCAN-O-MATIC MILLER

...and still the most mill for the least money

• Fully automatic, hydraulic three dimensional scanning and semi-automatic profiling with power and accuracy for versatile milling! • Automatically follows contour of master straight, angle or curved. • Uniform and accurate cut, since deflection remains constant. • Adjustable Stops • Adjustable Tracer Head • Conveniently Located Feed Control • Tracer Control Selector • Lever Operated Hydraulic Control Panel • Pick Feed Selector • Three dimensional or Conventional Vertical & Horizontal Milling •

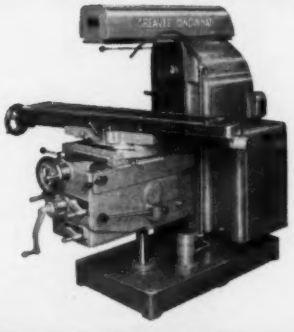


The 2H Mill

Rigid cast construction 5 HP—1750 RPM drive motor. Comprehensive speed-feed ranges. Big job capacity.

The 2 XH Mill

More POWER at the cutter. 2 motors—7½ HP spindle drive, separate motor for movable components. Heavy internally ribbed construction.



Complete Line of Milling Attachments Available
New Attractive Lease Plan!

GREAVES

GREAVES MACHINE TOOL CO., 2500 Eastern Ave., Cincinnati 2, Ohio
Please send me details on Greaves Scan-O-Matic Miller
NAME _____ TITLE _____
FIRM _____
ADDRESS _____
CITY, ZONE & STATE _____

For more data, circle this page number on Readers' Service Card

makes it most useful under servo control. Because of its considerable torque, the unit can operate lead-screws and drive-shafts directly (close-coupled through the hollow spindle) and without any intermediate gearing.

Circle 591 on Readers' Service Card

Ther-Monic Dual-Frequency Generator

A dual-frequency induction generator of exceptional versatility has been introduced by the Induction Heating Corporation, Brooklyn, N. Y., subsidiary of Hathaway Instruments, Inc. This new Ther-Monic generator can induce the equivalent of 50 kw into a square inch of surface, yet the shallow penetration depth at normal operating frequencies (5- to 8-megacycle range) permits efficient coupling of high power to small diameters.

Developed for the Convair Astronautics Division of General Dynamics Corporation, the new device makes it possible to utilize high levels of power in routine metallurgical processes, or in advanced research. Using frequencies in the 5- to 8-megacycle range, the work-coil and output circuit parameters can be selected so that strong fields are generated in remarkably compact areas. Output control of all frequencies is by saturable reactor, featuring line regulations, fast response, and manual or automatic control.

A 200-kc output station, with a variable ratio transformer and direct tank loading, insures maximum utility. Selection of kilocycle or megacycle output is made by a manual transfer switch. The change-over from transformer to direct tank loading is made by shifting links.

Circle 592 on Readers' Service Card

Cold-Heading Machine for Miniature Parts

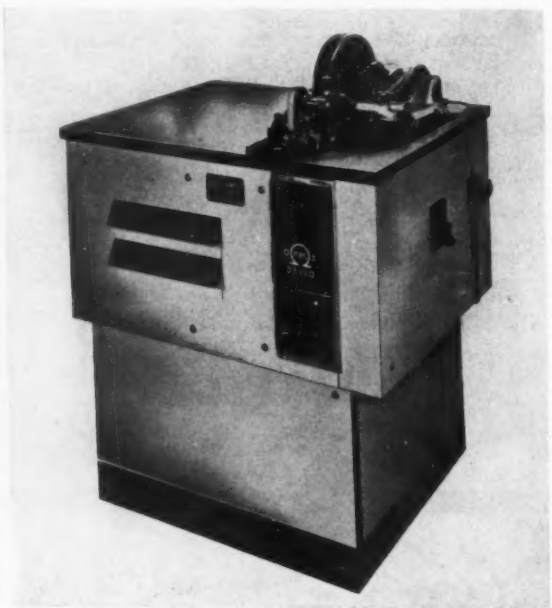
Rem Sales Inc., West Hartford, Conn., has announced an improved Model "00" solid-die, double-stroke Morris-Omega cold-header for miniature parts. The major design change consists of a variable-speed drive arrangement that allows instantaneous speed adjustment while the machine is in operation. By simply turning a hand dial (not visible in the illustration) the flywheel speed can be adjusted from 150 to 300 rpm, thus permitting the operator to gradually "tune in" to maximum practical operating speed after a job is set up.

The desk type cabinet base has tool storage drawers and work-receiving pans. The motor drive is housed in the cabinet, supported by a metal framework. The cold-header is provided with a one-shot lubricating system. The machine has a wire-diameter capacity of 0.012 to 0.070 inch. It was developed particularly for the manufacture of tiny components such as electrical contacts, optical screw blanks, and other miniature rivet forms. A special die-block and mechanism included with the standard equipment allows deep hollowing of rivet shanks in soft materials such as aluminum and fine silver, although the machine is not claimed to be a tubular rivet header. A single-stroke model for heading balls up to 0.0625 inch in diameter, finished size, is also available.

Circle 593 on Readers' Service Card

(This section continued on page 186)

Dual-frequency Ther-Monic generator introduced by the Induction Heating Corporation



Morris-Omega miniature-parts heading machine announced by Rem Sales Inc.

Snyder Corporation Applies Numerical Control to Dial Type Multi-Unit Machine

This new Snyder machine drills, reams and counterbores a wide variety of cast iron diesel fly-wheels by use of numerical controls. Fifteen different fly-wheels from 12⅝ inch to 20 inch diameter are processed with various control tapes. The wheel shown in the right foreground is unprocessed. Others are as they come from the machine, ready for assembly.

For the application illustrated, the machine has one vertical, one angular and two horizontal standard units which are mounted around a 34 inch diameter table indexing at 2 rpm while maintaining an indexing spacing accuracy of plus or minus 0.0005 inches on a 32 inch diameter.

This type of machine is equally adaptable to a wide variety of other low production metal cutting work and its versatility, accuracy and economy suggest many profitable applications.

Movies of the machine in action are available.

We'll be glad to show them at your convenience. Just phone or write.

SNYDER
CORPORATION
3400 E. LAFAYETTE—DETROIT 7, MICHIGAN
Phone: LO 7-0123

NEW CATALOGUES

Isabel Shamlian
Charles O. Herb, Jr.

Catalogues bring details of new products to prospective buyers in clear, concise form. Yours for the asking . . . use postcard on pp. 177 & 178

Keyseaters

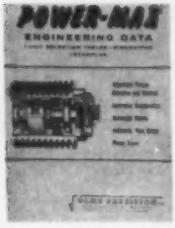
Davis Keyseater Co., Rochester, N. Y. Folder featuring details on the company's keyseaters, designed to cut single or multiple, straight or tapered, internal keyways. Sample cutting times and accessories are discussed. A specification card is included.

Circle **Item 501** on Inquiry Card

Motor-Winding Protection

U. S. Electrical Motors Inc., Los Angeles, Calif. Brochure No. F-2034 on solid-cast Everseal encapsulation for the protection of motor windings against severe environmental conditions such as chemical fumes, heat and cold, dust, water splash, etc.

Circle **Item 506** on Inquiry Card



Automatic Clutches

Olme Precision, Inc., Portsmouth, Ohio. Folder giving engineering and application data for "Power-Max" automatic, adjustable centrifugal clutches. Classes, ratings, and specifications for direct-drive, V-belt, and flat-belt units are supplied.

Circle **Item 502** on Inquiry Card

Hydraulic Shears

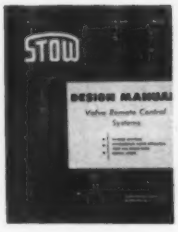
Verson Allsteel Press Co., Chicago, Ill. Catalogue VHS-61 (with slide calculator) on the firm's redesigned line of hydraulic shears. The slide calculator included simplifies the computation of the tonnage required to shear all commonly used metals.

Circle **Item 507** on Inquiry Card

Tooling Balls

Industrial Tectonics, Inc., Ann Arbor, Mich. Bulletin B-42 on stainless-steel tooling balls used in making and checking machining setups and assemblies where holes or surfaces must be accurately located at compounded angles or in two or more planes.

Circle **Item 503** on Inquiry Card



Valve Remote-Control Systems

Stow Mfg. Co. Inc., Binghamton, N. Y. Bulletin 618 on a line of manual remote controls as used on ships and in power plants, chemical plants, nuclear power plants, and industrial plants for valves. Included are dimensional sketches of all terminals.

Circle **Item 508** on Inquiry Card

Driving Centers

PowerGrip, Inc., Rockfall, Conn. Catalogue No. 50961 on the company's driving centers, which grip the end face of work, permit loading and unloading of work without stopping spindle, reduce backlash, permit machining work from end to end, etc.

Circle **Item 504** on Inquiry Card

Boring and Facing Heads

Giddings & Lewis Machine Tool Co., Fond du Lac, Wis. Catalogue No. D-550 covering a line of "CF" continuous-feed heads for boring, facing, turning, back-facing, recessing, threading, grooving, and other work. Twelve standard models are included.

Circle **Item 509** on Inquiry Card

Exhaust Hood

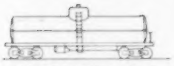
Pangborn Corporation, Hagerstown, Md. Bulletin No. 924 providing photographs and sketches which show how Pangborn's exhaust hood, combined with a synthetic-fabric dust collector, eliminates electric-furnace smoke and fumes. Applications are discussed.

Circle **Item 505** on Inquiry Card

Throw-Away Insert Tooling

Microbore Division, DeVlieg Machine Co., Royal Oak, Mich. Brochure MSD-101 discussing the latest additions and modifications of the firm's standard lines of screw-on and clamp-on cartridges employed with throw-away carbide cutting tool inserts.

Circle **Item 510** on Inquiry Card



WHY BUY A TANK CAR OF CUTTING OIL . . .

THAT CAN BE REPLACED WITH A DRUM OF SOLVOL 900 WATER-MIX CONCENTRATE . . .

PLUS WATER . . . SCOT FREE WATER!

PUTS YOUR CUTTING OIL COSTS ON ICE
. . . WATCH 'EM SKID!

Here's why—*SOLVOL 900 is scientifically formulated to contain the maximum amount of lubricity in a water-mix concentrate, without resorting to the use of sulfur, chlorine, or other chemical additives. This super lubricity characteristic provides several economical advantages for cutting fluid users:*

You can ***replace straight cutting oils*** *where tough machining jobs are performed on non-ferrous metals: Tapping—Threading—Broaching—Gear Shaping—Gear Hobbing—Automatic Bar and Chucking machine work.*

You can ***replace straight cutting oils*** *being used to machine ferrous materials in the medium to free machining range: Slab, Contour, Round Hole Broaching—Gear Shaping—Gear Hobbing—Gear Generating—Automatic Bar and Chucking machines.*

You can ***replace straight grinding oils*** *where high surface finish cylindrical and centerless jobs are performed on Stainless Steels—Monel—High Temperature Alloys—Aluminum.*

And you can use Solvol 900 at ***leaner mixtures*** *for other heavy duty water-mix cutting fluid jobs!*

Stuart

D. A. STUART OIL CO., LIMITED
2727 S. Troy St., Chicago 23, Illinois

Canadian D. A. Stuart Oil Co., Limited
43 Upton Road, Scarborough, Ontario, Canada

ONE QUARTER CENTURY
SERVING THE MACHINE TOOL NEEDS OF AMERICA

Push Buttons to Better Production

Each push button above represents a type of Machine Tool
that we regularly supply Metalworking Industries.

Write for Bulletin No. 25

Michigan®

Michigan Special Machine Co.

11449 TIMKEN AVENUE, WARREN, MICHIGAN

• Yours for the asking . . . use postcard on pp. 177 & 178

Adjustable-Speed Drives

General Electric Co., Schenectady, N. Y. Bulletin GEA-6999 defining adjustable-speed drives and their role in industry. Also included are product description and application, factors in drive selection, and examples of special applications.

Circle **Item 511** on Inquiry Card

Precision Gears

Perfect Gear & Instrument Corporation, Inglewood, Calif. Catalogue No. 6A offering a line of stock miniature gears in Precision I, II, and III. Also included are specifications for stock precision clamps, bearings, shafts, retaining rings, etc.

Circle **Item 517** on Inquiry Card

Groove Gages

Boice Gages, Inc., Hyde Park, N. Y. Catalogue 1-A discussing dial-indicating groove gages for O-ring and snap-ring grooves, manufactured by the firm's new subsidiary, Reliant Gages, Inc. They may also be used to check bore diameters, deep holes, etc.

Circle **Item 512** on Inquiry Card

Speed Reducer

Dodge Mfg. Corporation, Mishawaka, Ind. Bulletin 602A giving details on a small shaft-mounted speed reducer—latest addition to the Torque-Arm line. It is designed for shafts 1 1/2 inches or less, and for power requirements up to 1 hp at 90 rpm.

Circle **Item 518** on Inquiry Card

Multiple Transfer Presses

Baird Machine Co., Stratford, Conn. Brochure presenting four representative models of the Baird multiple transfer-press line. Information on rated capacity (in tons) and production speed capability and a listing of typical applications are offered.

Circle **Item 513** on Inquiry Card

Indexing Units

Standard Tool & Mfg. Co., Lyndhurst, N. J. Bulletin No. 26 presenting information on two Model ST-A9AB cam-operated indexing units—basic and precision types. Indexing cams and dial plates, machine bases, motors, and electric timers are described.

Circle **Item 519** on Inquiry Card

Control Centers

Monitor Controller Division, Atlee Corporation, Rockland, Mass. Bulletin C-6300 presenting data on laying out and designing any control center—special or standard. Simplified planning and ordering, less-expensive installation, etc., are covered.

Circle **Item 514** on Inquiry Card

Press Brakes

Dreis & Krump Mfg. Co., Chicago, Ill. Bulletin T 265-61 presenting two models in light-duty press brakes—both with 25-ton capacity. Features include rigid frame of welded-steel plate, deep section bed and ram, infinitely variable speed drive, etc.

Circle **Item 520** on Inquiry Card

Magnetic Filtration

Eriez Mfg. Co., Erie, Pa. Bulletin B-38 describing powerful, permanent magnetic devices which provide protection for liquid lines and processing equipment threatened with iron contamination. Details on the Model L-2-F ferrous trap are given.

Circle **Item 515** on Inquiry Card

Grinding Wheels

Simonds Abrasive Co., Philadelphia, Pa. Bulletin (Form ESA-323) covering the firm's RA Borolon V8 vitrified-bonded grinding wheels, containing man-made rubies as the abrasive. Grain and grade recommendations, grinding suggestions, etc., are detailed.

Circle **Item 521** on Inquiry Card

Milling Cutters

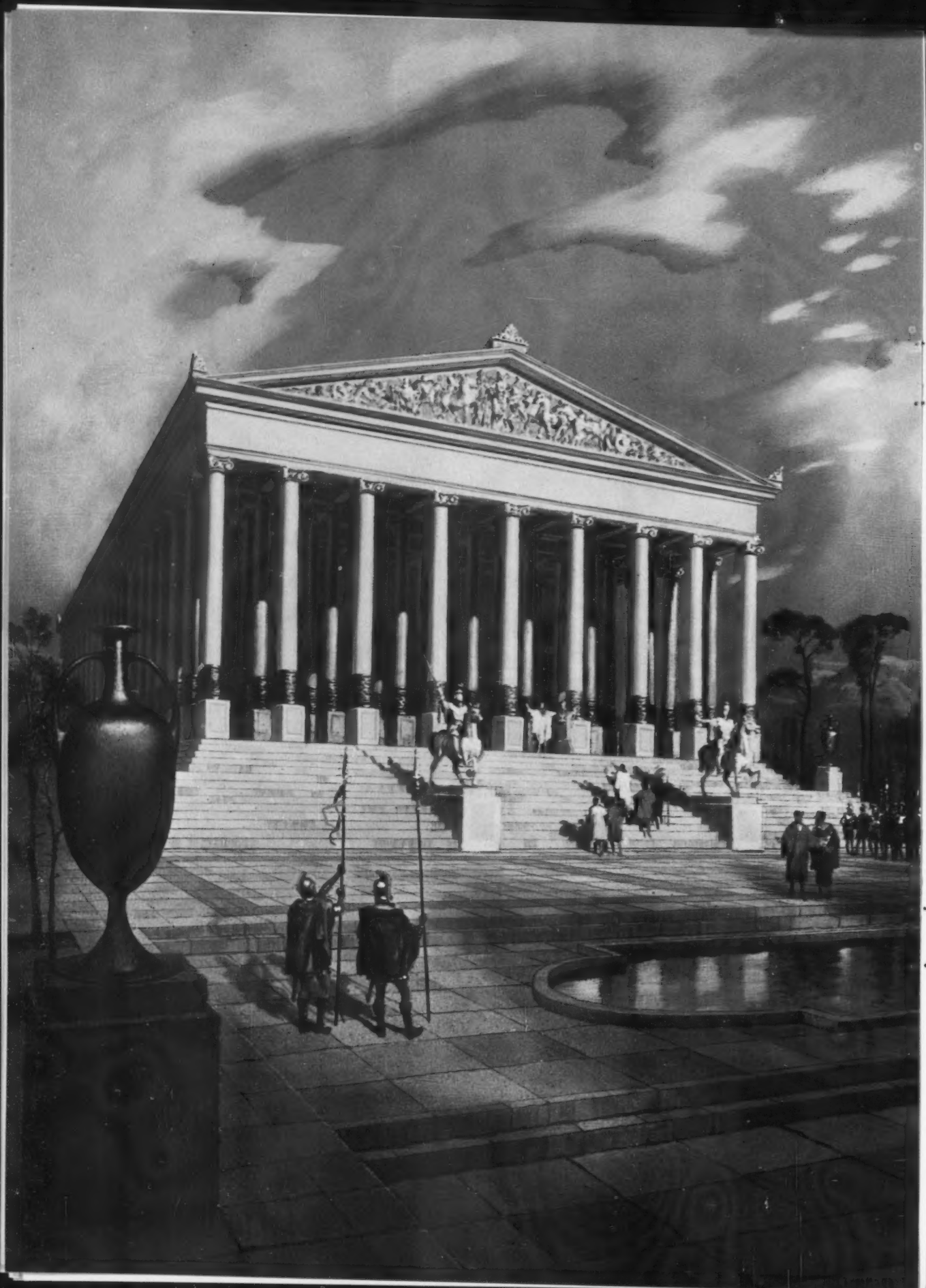
Vascoloy-Ramet Corporation, Waukegan, Ill. Catalogue 6103 describing V-R throw-away insert face mill cutters for rough, semirough, and finish milling. Seven design features that provide economical operating advantages are outlined, along with accessories.

Circle **Item 516** on Inquiry Card

Drilling Machines

Burgmaster Corporation, Gardena, Calif. Catalogue providing details on six- and eight-spindle automatic hydraulic turret drilling machines. Optional features and attachments include automatic tape controls that adapt the machines to wide ranges of work.

Circle **Item 522** on Inquiry Card

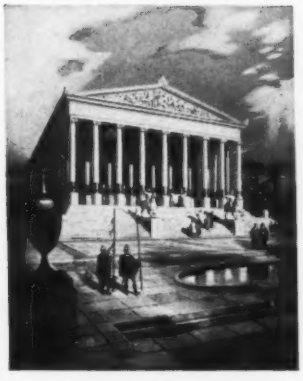


temple of diana

More visitors were attracted to the Temple of Diana than to any other building in the ancient world. And no wonder—its size and beauty were awe inspiring, attracting pilgrims from near and far. Its selection as one of the "7 Wonders of the Ancient World" is borne out by Pliny, historian of ancient Rome, who described it . . . "the most wonderful monument of Grecian magnificence."

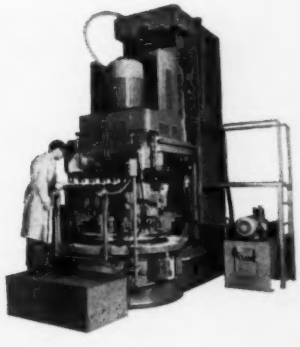
In our modern industrial civilization, production machinery also attracts many observers – both casual and those with considerable knowledge of manufacturing processes. The latter "expert" group quickly takes note of exceptional performance that "goes beyond usual industry practices."

In the opinion of many of these experts, this quality distinguishes Lamb machines. Exceptional methods, reliability, performance and manufacturing economy are outstanding benefits. Investigate Lamb's experience and creative engineering for the best solution to your manufacturing problem.



It took more than a century to complete the Temple of Diana, largest temple of the ancient Greek world and located at Ephesus, Asia Minor. Designed by Chersiphron, the temple was 425 ft. long, 225 ft. wide and had 127 marble columns 60 ft. high, each weighing 150 tons. Destroyed by fire in 365 B.C., it was rebuilt by Praxitiles and finally destroyed by Alaric the Goth in 263 A.D.

One of a series of paintings by Mario Larrinaga, commissioned by F. Jos. Lamb Co. Copies suitable for framing available on request.



F. JOS. LAMB CO.

5663 E. NINE MILE ROAD • DETROIT 34, MICHIGAN

9885

Since 1914 Engineers and Builders of Special Machines and Automation Equipment

• Yours for the asking . . . use postcard on pp. 177 & 178

Asbestos Gloves

Asbestos Cloth Products Co., Los Angeles, Calif. Brochure describing Dura-Weave asbestos gloves, which are guaranteed for triple wear at 1700 degrees F. Four styles are available: five-finger glove and one-finger, regular, and reversible mitt.

Circle **Item 523** on Inquiry Card

Turning Tools

Valenite Metals, a division of Valeron Corporation, Royal Oak, Mich. Bulletin HS-61 on Hi-Shear turning tools, which feature positive-rake angles up to 13 degrees with lapped inserts and chip-breakers. They are available in six standard holder styles.

Circle **Item 529** on Inquiry Card

Electromechanical Lead-Screw Unit

Foote-Burt Co., Cleveland, Ohio. Data Sheet FB-76 on a positive-feed electromechanical lead-screw unit for drilling, boring, reaming, counterboring, spot facing, chamfering, or milling, which can feed against a positive stop and provide tool dwell.

Circle **Item 524** on Inquiry Card

Wet-Blast Units

Pressure Blast Mfg. Co., Inc., Manchester, Conn. Brochure describing a line of eight wet-blast units. Data on the difference between "high velocity" and "regular velocity" wet-blasting processes, optional attachments, special nozzles, etc., are included.

Circle **Item 530** on Inquiry Card

Hard Surfacing

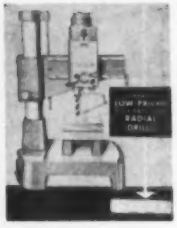
Kennametal Inc., Latrobe, Pa. Booklet No. B-175A containing data on how to apply tungsten-carbide hard facing. Four forms of hard-surfacing materials are covered: tube Kenface, Kenface bulk powder, Kenspray powder, and Kenface Arc Rod KT-200.

Circle **Item 525** on Inquiry Card

Dynamic and Static Balancers

Gisholt Machine Co., Madison, Wis. Revised catalogue (Form 1165-C) on the Type "S" dynamic (two-plane) and static (single-plane) balancing machines. Photographs show the wide range of long- and short-run parts that have been balanced on this equipment.

Circle **Item 531** on Inquiry Card



Radial Drills

Boice-Crane Co., Toledo, Ohio. Brochure on high-precision radial drills. Mechanical spindle brake, automatic depth stop on spindle, automatic tool ejector, extra-sensitive hand feed, plus usual hand feed are described. Specifications are included.

Circle **Item 526** on Inquiry Card

Mounted Wheels and Points

Simonds Worden White Co., Dayton, Ohio. Bulletin 660 featuring Dayton Safety mounted wheels and points, a line of abrasive products for offhand and precision grinding applications. They are available in standard A, B, and W shapes and sizes.

Circle **Item 532** on Inquiry Card

Milling Machines

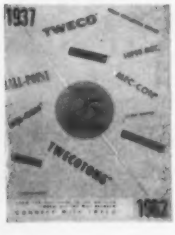
Brown & Sharpe Mfg. Co., Providence, R. I. Bulletin MM 57 containing data on four Dynamaster No. 2 vertical milling machines. Detailed are such features as automatic metered lubrication, heavy-duty feed-screws, and conveniently grouped controls.

Circle **Item 527** on Inquiry Card

Gas Burners

Selas Corporation of America, Dresher, Pa. Bulletin DB-2 on Duradiant burners, a line of "complete premix" radiant type gas units. Design features, construction, and operating principles are covered, with a listing of the types available.

Circle **Item 533** on Inquiry Card



Arc-Welding Accessories

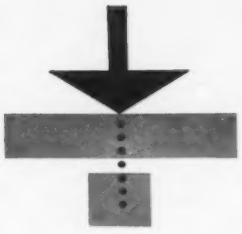
Tweco Products, Inc., Wichita, Kan. Catalogue No. 13 containing data on welding equipment, including electrode holders, ground clamps, cable connectors, lugs, and splicers. Also discussed is the ball-point cable connection, now on all Tweco products.

Circle **Item 528** on Inquiry Card

Milling Cutters

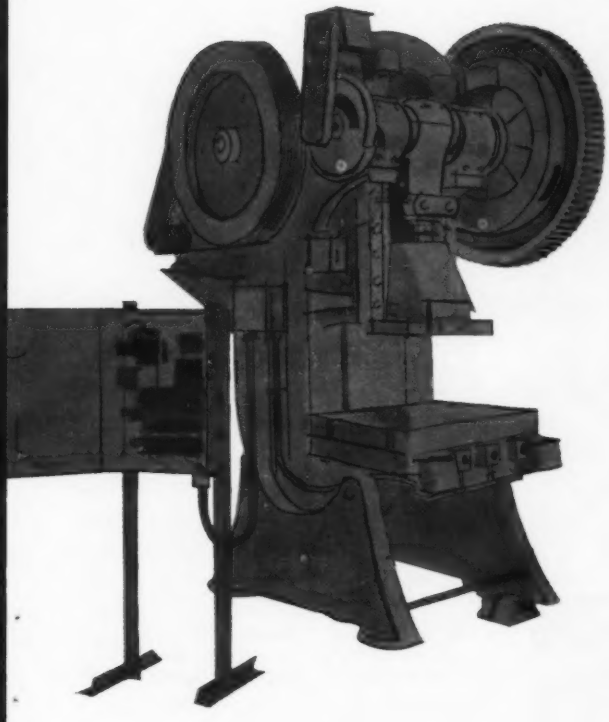
Vascoloy-Ramet Corporation, Waukegan, Ill. Catalogue 6104 covering the company's Rigidcut and Varicut inserted-blade milling cutters. Rigidcut fine- and coarse-pitch series, and Varicut plain, half-side, and staggered-tooth series are described.

Circle **Item 534** on Inquiry Card



Gain higher speeds- lower maintenance- longer press life!

FEDERAL AIR CLUTCH PRESSES



The new Federal friction-type air clutch is designed specifically for presses . . . operates on controlled air pressure . . . uniformly engages a full 360 degrees of friction surface. An air solenoid, regulated by interlocking control circuits, activates the clutch. When diaphragm is expanded, *instant and total contact* is established. Flywheel mounting reduces the mass to be put into motion. Minimum movement and the elimination of drag on the brake assures fast engaging and disengaging at *any speed. Never requires adjustment.* Uniform distribution of torque, elimination of concentrated stresses, overload protection and shock-free engagement mean longer life!

Check the comparison chart below. Feature for feature—dollar for dollar, Federal Air Clutch Presses are your best buy! Write for catalog.

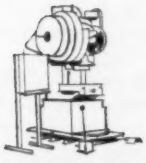
FEATURES	FEDERAL	PRESS A	PRESS B
Fail-safe Control	Yes	No	No
Dual Solenoid Valve	Yes	No	Yes
Air Filter Lubricator Pressure Regulator	Yes	No	No
Meehanite Castings	Yes	Yes	No
Anti Tie-down Push Buttons	Yes	No	Yes
Stranded Wire	Yes	Yes	No
Solderless Connections	Yes	No	No
Emergency Stop	Yes	No	Yes
Top Stop	Yes	No	Yes
Selector Switch	Yes	Yes	No
Guarded Foot Switch	Yes	No	No
Oil-tight Enclosures	Yes	No	Yes

FEDERAL

open-back inclinable

PRESSES

Horizontal Presses



Flying Cutoff Presses

Extruding Presses

Dial Feed Presses

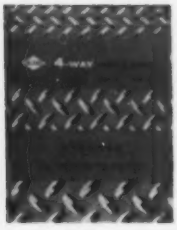
THE FEDERAL PRESS COMPANY of Elkhart, Indiana, Dept. 901

• Yours for the asking . . . use postcard on pp. 177 & 178

Lubricating Grease

Bardahl Mfg. Corporation, Seattle, Wash. Booklet covering the basic principles, properties, types, and rules for choice and application of lubricating grease. Included is a discussion of the effect of additives on the properties of grease.

Circle **Item 535** on Inquiry Card



Steel Flooring

Joseph T. Ryerson & Son, Inc., Chicago, Ill. Bulletin on three thicknesses of raised-lug pattern steel plate for use as a safety flooring material and in constructing slip- and fire-resistant steps, stairs, ramps, column covers, platforms, etc.

Circle **Item 536** on Inquiry Card

Hydraulic Power Packages

Vickers Incorporated, Detroit, Mich. Bulletin 61-82 on motorized hydraulic power packages, containing pump, electric motor, valving, and reservoir in one compact unit, which can be used in practically any hydraulic application. Three series are available.

Circle **Item 537** on Inquiry Card

Speed Changers

Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 51B9061B presenting design features of the company's Vari-Tex speed changer. Available in five case sizes, it provides stepless speed changes within standard speed ranges of 2 to 1 through 10 to 1.

Circle **Item 538** on Inquiry Card

Suspended Magnets

Stearns Magnetic Products Division, Indiana General Corporation, Milwaukee, Wis. Bulletin No. 1032 describing the firm's line of oil-filled suspended magnets. Helpful information on the use of automatic tramp-iron removal assemblies is included.

Circle **Item 539** on Inquiry Card

Optical Polygon

Michigan Tool Co., Detroit, Mich. Bulletin X60-B giving a description of the company's Model MOX-3600 Milichex optical polygon for use in checking alignment and angular spacing in any multiple of full degrees. Accuracy is within 1/4 second of arc.

Circle **Item 540** on Inquiry Card

Heat-Treatment

Link-Belt Co., Chicago, Ill. Folder 2922 on the Spin/Hard heat-treatment of sprockets, gears, traction wheels, and other products requiring hardened areas for high wear resistance. Spin/Hard components are used on bucket elevators, apron conveyors, etc.

Circle **Item 541** on Inquiry Card

Electric Gaging

Hamilton Watch Co., Lancaster, Pa. Booklet GB-2 explaining the function of the Hamilton electric indicator and control units. Also included are typical applications of electric gaging to reduce the cost of parts fabrication and inspection.

Circle **Item 542** on Inquiry Card

Cutting-Tool Literature

Brown & Sharpe Mfg. Co., Providence, R. I. Bulletin (Form C-48) published as a guide to all the firm's available literature, to help distributors and users of B&S cutting tools. Thirty brochures, booklets, catalogues, and article reprints are described.

Circle **Item 543** on Inquiry Card

Damped Laminates

Lord Mfg. Co., Erie, Pa. Bulletin No. 719 giving advantages of standard and custom-engineered Dyna-damp structures in protecting sensitive equipment exposed to random high-intensity vibration, shock, and noise. Examples of applications are given.

Circle **Item 544** on Inquiry Card

Variable Displacement Pump

Weatherhead Co., Cleveland, Ohio. Bulletin containing information on the firm's W07 variable displacement pump. Features include only two rotating members, hydraulically balanced stationary face seals throughout the high-pressure pumping path, etc.

Circle **Item 545** on Inquiry Card

Instrument Making

C. L. Berger & Sons, Inc., Boston, Mass. Circular featuring the products and facilities of the firm's Instrumentation & Apparatus Division. Precisely graduated dials and verniers, tapered spindle accurate to 0.00005 inch, etc., are covered.

Circle **Item 546** on Inquiry Card

Note that sizes are etched on the *sides* of the blocks so that they always are visible and can be easily read even when wrung together

Even the case is more productive—self-indexing, and designed so that the user need not touch the gaging surfaces to remove the blocks.

a DoALL PRODUCTIVITY-PLUS product

STAINLESS STEEL Gage Blocks

...a lot more value for just a little more money

LONGER LIFE . ASSURED ACCURACY . FASTER, EASIER GAGING . LOWEST COST IN THE LONG RUN

You'll greatly increase the productivity and reduce the cost of your gaging operations when you buy DoALL *stainless steel* gage blocks. No other blocks give you such an impressive list of economic plus values:

Wear life is triple that of ordinary steel gage blocks.

Extraordinary stability—independent laboratory tests show no measurable dimensional change after 24 months.

Coefficient of expansion in the range of nearly all ferrous metals, eliminating error-producing, time-wasting temperature compensations required, for example, with chrome carbide blocks.

0.09 RMS surface finish—far superior to that available on blocks of any other material or make; assuring greater accuracy, easier wringability, and maximum wear life.

High Brinelling resistance—repeated spindle impacts will not Brinell these stainless steel blocks.

Four to five times greater corrosion resistance than regular steel blocks.

68-72 Rockwell C hardness—for longer life with fewer recalibrations.

LOW PRICE. When you consider the greatly extended wear life, the unequaled finish, the workable coefficient of expansion, the ultra-stable accuracy, and the ease of wringability of DoALL stainless steel gage blocks, you will find that they give you more practical value, dollar for dollar, than any other blocks you can buy. For example, a 2" AA grade SS block at $18.25 costs *only $5.75 more* than a standard steel block and *as much as $41.75 less than* a chrome carbide block.

Get all the facts—ask for a demonstration. Call DoALL today.

THE DoALL COMPANY, Des Plaines, Ill.
Serving you locally through your DoALL Sales-Service Store

GB-41

DoALL . . . the Productivity People

*Reg. T.M.—The DoALL Company

CALL YOUR DoALL SALES-SERVICE STORE

MACHINE TOOLS

Price $10,336 — Rent $86.21 per week
Model 2613-3
Contour-matic®
23 types
BAND MACHINES

Price $1475 — Rent $9.46 per week
Model DH-612
6" x 12"
12 types
SURFACE GRINDERS

Price $2761 — Rent $17.70 per week
Model C-12
6 types
POWER SAWS

CUTTING TOOLS

18 types
All sizes

MEASURING INSTRUMENTS

SHOP BLOCKS® 84 pcs.

Price $265

18" x 24"
Price $80
All sizes, grades

SHOP SUPPLIES

For Every Purpose

2,000 Sizes • grades

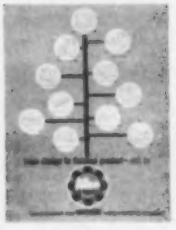
Find Your DoALL STORE In The "Yellow Pages"

• Yours for the asking . . . use postcard on pp. 177 & 178

Vibration/Shock/Noise Control

Lord Mfg. Co., Erie, Pa. Brochure on the use of bonded rubber mountings for control of vibration, shock, and noise. Resilient mountings, elastomer products, Dynafocal suspensions, Dynaflex joints, railroad products, and flexible couplings are presented.

Circle **Item 547** on Inquiry Card



Allen Services and Equipment

Allen Tool Corporation, Syracuse, N. Y. Brochure showing the range of engineering and production capabilities and the extensive equipment of the company. Contract machining, machine design and construction, jigs and fixtures, etc., are described.

Circle **Item 548** on Inquiry Card

Electric Hoists

Wright Hoist Division, American Chain & Cable Co., Inc., York, Pa. Catalogue DH-173 presenting Speedway frame W1 electric hoists, with overload cutoff to protect the operator, load, and hoist against possible unsafe results from extreme overloads.

Circle **Item 549** on Inquiry Card

Gun Drills

Star Cutter Co., Farmington, Mich. Catalogue sheet SC-169 on Star Double-Jet gun drills, which are said to provide up to three times the tool life of single-hole gun drills in many applications. Photographs and case-history information are included.

Circle **Item 550** on Inquiry Card

Broaches

DuMont Corporation, Greenfield, Mass. Catalogue covering the company's complete line of Minute Man broaches. Sizes and specifications are given for keyway broaches and kits, and square, round, and hexagonal broaches. Operating information is included.

Circle **Item 551** on Inquiry Card

Air Power Presses

Hannifin Co., Des Plaines, Ill. Bulletin 0960-B1 cataloguing all Hannifin air power presses. Dimensioning and technical information for open-gap and column air presses in bench and floor-mounting models are given. Thirty-four sizes are offered.

Circle **Item 552** on Inquiry Card

Conveyors

May-Fran Mfg. Co., Cleveland, Ohio. Bulletin 200 B featuring the firm's components, which provide conveyor customizing from standard sections. Curved sections, concave, and convex can be regularly supplied in 30-, 45-, 60-, 75-, and 90-degree bends.

Circle **Item 553** on Inquiry Card

Radii Finisher

Michigan Tool Co. Detroit, Mich. Data Sheet 1026-61 presenting technical information on the firm's Roto-Flo Model 1026 radii finisher, a burnishing machine that strengthens parts at critical fillets by cold-working and compacting the surface.

Circle **Item 554** on Inquiry Card

Lathe Turrets

Enco Mfg. Co., Chicago, Ill. Expanded catalogue on the company's line of lathe turrets, Micro-Set adjustable centers, and Tiny-Titan magnetic-base tools. Each of the seven basic types is completely described, illustrated, and dimensioned.

Circle **Item 555** on Inquiry Card

Press Brakes

Verson Allsteel Press Co., Chicago, Ill. Catalogue JI-61 providing design details and specifications for the company's "Junior" and "Intermediate" size mechanical press brakes. Three series with capacities of 50, 65, and 90 tons are described.

Circle **Item 556** on Inquiry Card

Turret Toolposts

Frehan Co., Pasadena, Calif. Catalogue featuring details on the firm's Turntool turret toolposts, which fit standard holders on 9- to 13-inch swing lathes without special machining or installations. Extra attachments plus price list are included.

Circle **Item 557** on Inquiry Card

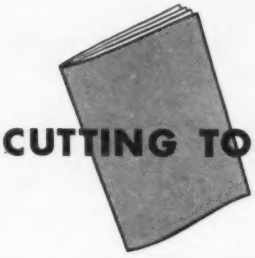
Plasma Equipment

Precise Metal Products Corporation, Brooklyn, N. Y. Circular giving data on a line of plasma spraying and generating equipment, which can generate temperatures in excess of 30,000 degrees F. and spray coatings of any material with a melting point.

Circle **Item 558** on Inquiry Card

catalogues . . . . bulletins . . . . manuals

• Yours for the asking . . . use postcard on following page



Circular Tool Co. offers catalog showing more than 1200 items in their line of **SAWS, SLITTERS** and combination center **DRILLS.** To obtain circle 171

Illinois Tool offers a guide to **MILLING CUTTER** application, evaluation and cost analysis. To obtain circle 195

Textile Machine Works booklet "Facilities File Folder" describes their **SUBCONTRACTING** facilities. To obtain circle 18

Ex-Cell-O Corp. offers Catalogs & Bulletins on their line of **DRILL JIG BUSHINGS.** To obtain circle 27

Inland Steel Co. offers informative booklet—"Properties of Ledloy **STEELS."** To obtain circle 31

Texaco—**CUTTING OIL** booklet "Cleartex in Automatic Screw Machines" features, cutting oil dilution problems. To obtain circle 34

Universal Engineering Co., offers a catalog on their line of Production Tools, featuring their **LOCATING PIN.** To obtain circle. 36

Sheffield Corp. offers catalog on their **GAGING** equipment titled "The Cessna Story and Precisionaire Catalog." To obtain circle 42

S-P Manufacturing Co., offers a catalog featuring their line of Power **CHUCKS** and air or Hydraulic rotating **CYLINDERS.** To obtain circle 212

To obtain additional information on the Engis Equipment Company's new electronic **LEVEL**—designed for use in places where reading a block level is difficult. Circle 214

Free sample of the Lloyd Tool Company's odor free, concentrated Mist **COOLANT.** To obtain circle. 227B

Barry Controls offers a new bulletin giving the advantages of using their **MOUNTINGS** for layout flexability as opposed to the stationary bolting down of machinery. To obtain circle 228

Buck Tool Co. offers catalog on their line of Manual and Power **CHUCKS.** To obtain circle 233

Ex-Cell-O Corp. offers a catalog on their line of **HYDRAULIC POWER UNITS.** To obtain circle 23

De Laval Co. offers a bulletin featuring; application and performance data, dimension drawings and tables and selection information on their line of Power & Hydraulic **PUMPS.** To obtain circle . . 70

Cincinnati Gear Co. offers brochure on their line of **GEARS,** made in all types, to 72" diameter cut teeth, 39" shaved teeth and 25" ground teeth. To obtain circle 151

Miniature Precision Bearings, Inc., offers catalog on MPB **BEARINGS,** including new sizes and types. Circle item . . 176B

To obtain the Ruthmann Machine Co's catalog featuring their line of **COOLANT PUMPS.** Circle 190

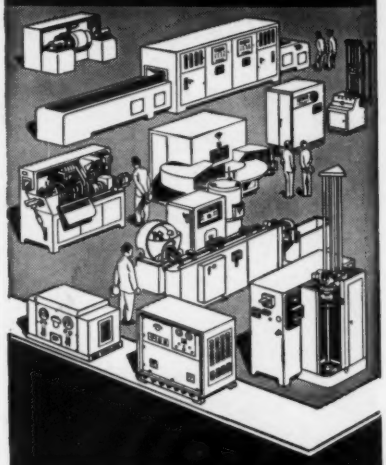
Allen-Bradley Co., offers catalog describing the line of **MOTOR STARTERS.** To obtain circle. 197-198

Ball & Roller Bearing Co. offers a catalog to aid you in your selection of their precision **BEARINGS.** To obtain circle 227C

Eisler Engineering Co. offers catalog 55-C featuring their line of **CAMS.** To obtain circle 229B

Continued on page 176

for HARDENING • BRAZING
SOLDERING • FORGING • ANNEALING
MELTING • SINTERING • WELDING
REFINING • SHRINK FITTING
CRYSTAL GROWING



THER-MONIC

Manufactures the most complete range of

INDUCTION HEATING EQUIPMENT

ELECTRONIC • LOW FREQUENCY
MOTOR GENERATOR

THER-MONIC feature.

• Over 20 years of concentrated experience.

• Over 5,000 installations.

• Over 15,000 heating applications resolved in our customer service laboratories.

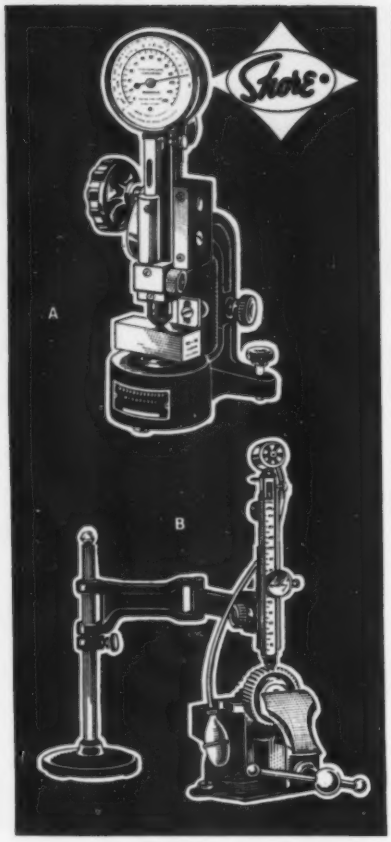
• This outstanding experience and know-how qualify us to prescribe the techniques and equipment best suited for your requirement.

Contact our factory or your local IHC representative.

Write for New 56-page catalog of exclusive features, facts and specs.

INDUCTION HEATING CORP.
181 WYTHE AVE., BROOKLYN 11, N.Y.

Subsidiary of Hathaway Instruments, Inc.
Circle page number on Readers' Service Card.



HARDNESS TESTING

Shore's Improved Direct Reading Scleroscope and Standard Recording Scleroscope with dial graduated in standard Scleroscope and equivalent Brinell and Rockwell "C" Hardness Numbers, are able to perform over 1000 hardness tests per hour. Both Scleroscopes are completely portable, operative on all types and sizes of metals, are reliable in hands of non-technical help, and show no visible injury signs on finished surfaces. Write for free brochures on these instruments.

A Standard Recording Scleroscope with Clamping Stand, jaw capacity 3" high x 2½" deep. Supplied with following accessories: diamond hammer, hard and soft test block, V block for testing rounds, and steel carrying case.

B Direct Reading Scleroscope shown above with special Swing Arm & Post Assembly. Height capacity 9", reach 14". To be mounted on bench for testing large objects. Supplied wih two test blocks and diamond hammer.

Let us send you complete specifications

THE Shore INSTRUMENT and MANUFACTURING Co., Inc.
90-35 Van Wyck Expressway, Jamaica 35, N. Y.

Circle 176A on Readers' Service Card

Continued from page 175

Burgmaster Corp. offers literature describing their 6 and 8 spindle tape controlled turret **DRILLING, TAPPING** and **BORING** machines. To obtain circle 16-17

Verson Allsteel Press Co. offers bulletin featuring—design details and specifications for their line of **SHEARS.** To obtain circle 20

To obtain full details on the E.W. Bliss line of **PRESSES,** get their new full-color catalog. Circle 37

To obtain additional information on the U. S. Drill Head Co. line of adjustable and fixed center multiple **DRILLING HEADS** and multiple **TAPPING HEADS.** Circle 38

For information on the Gisholt Machine Co's new **SUPERFINISHER** for flat, conical or spherical surfaces. Circle 52

La Salle Machine offers catalog showing examples of new, modern machine construction methods using their **BUILDING BLOCK** units. To obtain circle 53

Steelweld Machine offers a catalog describing their line of versatile **SHEARS.** To obtain circle 68

To obtain additional information on the new line of **BORING** machines from the New Britain Machine Co. Circle .. 68A

New Britain Machine Co., offers catalog on their new line of **CHUCKING** machines. To obtain circle 68B

Wickes Machine offers brochure #261 "Wickes **CRANKSHAFT LATHE".** To obtain circle 159

Federal Press Co. offers catalog featuring their line of **AIR CLUTCH PRESSES.** To obtain circle 171

Induction Heating Corp. offers 56-page catalog of exclusive features of their line of **INDUCTION HEATING** equipment. To obtain circle 175

Geo. T. Schmidt Inc. offers catalog #18 describing the line of automated **MARKING** equipment. To obtain circle .. 188

Winslow Products offers literature on their **DRILL POINTER**—handles drills from 1/32" to 1 1/2" diameters. To obtain circle 194

Cincinnati Shaper Co. offers catalog on their line of Mechanical or Hydraulic **SHEARS.** To obtain circle 201

Burgmaster Corp. offers literature on their line of bench model **TURRET DRILLS**—Units are mounted on old rivet machines, to get added throat depth. To obtain circle 202

Nebel Machine offers catalog on their high speed **LATHE**—with an exclusive coaxial spindle design. To obtain catalog circle 203

Goss and DeLeeuw offers new illustrated literature describing their new development of **CHUCKERS.** To obtain circle 206

Gallmeyer & Livingston Co. offers literature on their line of hydraulic feed **SURFACE GRINDERS.** To obtain circle 210-211

Armstrong-Blum Mfg. Co., offers catalog featuring their line of **BAND SAWS.** To obtain circle 215

Hamilton Tool Co., offers bulletin on their new **DRILLING MACHINE**—complete descriptions include sectional drawings. To obtain circle 216

Edlund Machine Company's new high speed, versatile **TAPE CONTROL** machine drills printed circuit boards with accuracy in a wide variety of materials. To obtain additional literature circle 217

Beatty Machine Co., offers bulletin containing full information on their **ROTARY SHEARS.** To obtain circle 218

Benchmaster Co. offers a circular on its Automatic Precision **ROLL FEED MACHINE,** accurately feeds measured lengths within a few thousanths—To obtain circle 226

Pacific Presses offers brochure on their Hydraulic **PRESS BRAKE.** To obtain circle 227D

Sunstrand Machine Co., offers catalog featuring their line of "Rigid" **MILLING** machines. To obtain circle 894

Barnes Drill Co., offers a catalog giving detailed story on their line of **HONING** machines. To obtain circle. 895

Sunstrand Machine offers Bulletin giving detailed dimensional data and specifications for all models of their line of "Convertible" **BROACHING** machines. To obtain circle. 896

feel free to use cards below . . .
to obtain free literature on products advertised or described in this issue

1. Circle page numbers of advertisements—if no page number appears on ad, refer to advertisers' index.
2. Circle item numbers of new equipment, catalogue descriptions.
3. Mail . . . we'll do the rest.

For Advertisements—Circle Page Numbers

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	68A	68B	69	70
71	72	73	74	75	76	142	143	147	149	151	153
155	157	159	161	163	165	166	168	169	171	173	175
176A	176B	179	181	183	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199	200	201	202	203
204	205	206	207	208	209	210	211	212	213	214	215
216	217	218	219	221	222	223	224	225	226	227A	227B
227C	227D	227E	228	229A	229B	229C	229D	230	231	232A	232B
233	234A	234B	234C	235A	235B	235C	235D	235E	239A	239B	240
891	892	893	894	895	896						

COVERS: FRONT — INSIDE FRONT — INSIDE BACK — BACK

For New Equipment, Catalogues—Circle Item Numbers

501	502	503	504	505	506	507	508	509	510	511	512
513	514	515	516	517	518	519	520	521	522	523	524
525	526	527	528	529	530	531	532	533	534	535	536
537	538	539	540	541	542	543	544	545	546	547	548
549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572
573	574	575	576	577	578	579	580	581	582	583	584
585	586	587	588	589	590	591	592	593	594	595	596
597	598	599	600	601	602	603	604	605	606	607	608
609	610	611	612	613	614	615	616	617	618	619	620
621	622	623	624	625	626	627	628	629	630	631	632
633	634	635	636	637	638	639	640	641	642	643	644
645	646	647	648	649	650	651	652	653	654	655	656

Please print 11/61

NAME .....

TITLE .....

COMPANY .....

CO. ADDRESS .....

CITY ..... ZONE .... STATE .....

information center

Reverse side of this card gives instructions on how to use postcards below to obtain new catalogues, data on new equipment described, and products advertised in this issue.

This card expires February 1, 1962

FIRST CLASS
Permit No. 53
New York, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY

MACHINERY
93 WORTH STREET
NEW YORK 13, N.Y.

READERS' SERVICE DEPT.

This card expires February 1, 1962

FIRST CLASS
Permit No. 53
New York, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY

MACHINERY
93 WORTH STREET
NEW YORK 13, N.Y.

READERS' SERVICE DEPT.

Another Special by Cross

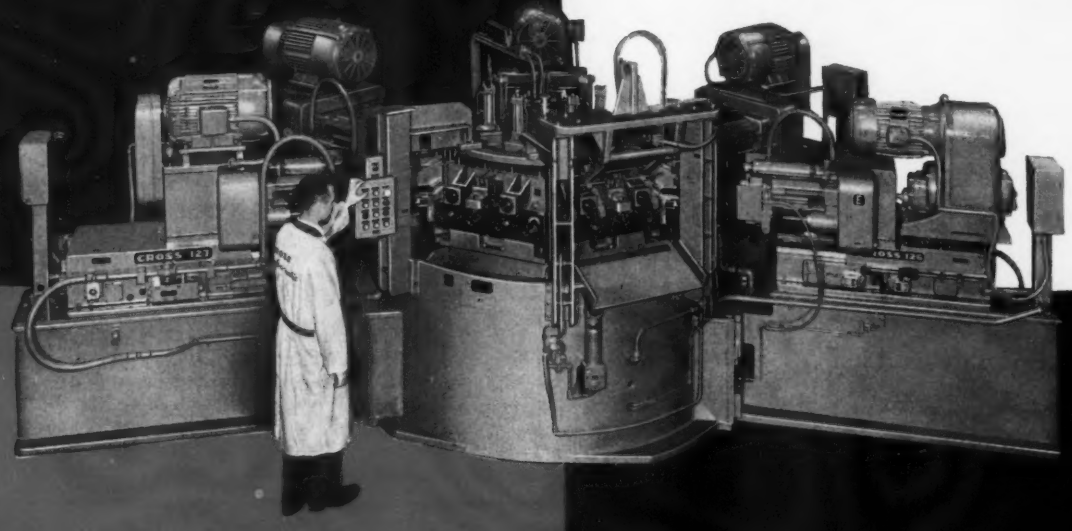
FLEXIBILITY
to process 25 different parts

Flexibility is featured in this Cross machine. One machine processes a variety of 25 different parts. The key to this flexibility is the fixture which holds any one of these varied parts with simple adapter changes.

The machine produces 675 pieces per hour and automatically unloads them onto a conveyor.

An improved chip and coolant system includes a conveyor that reaches right into the machine to remove the stringy chips.

The flexibility and efficiency you require is available in special machines by Cross.

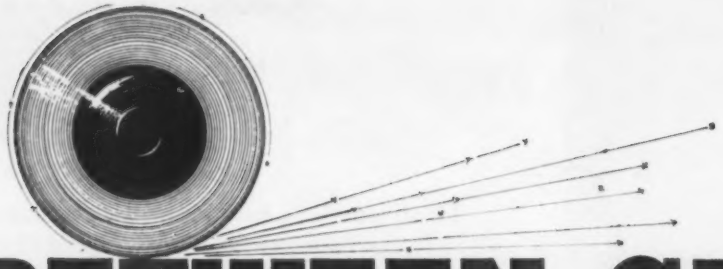


Established 1898

THE CROSS CO.

First in Automation

PARK GROVE STATION • DETROIT 5, MICHIGAN



By E. S. Salichs

BETWEEN GRINDS

Success with Skirts

Ablative skirts are now an important part of Titan second-stage engines, and are being developed and produced by the Liquid Rocket Plant of Aerojet-General Corporation. The skirt, which is made of nonmetallic materials, allows a "dry jacket" engine start, eliminating the potential hazard of propellant mixture leakage in the combustion chamber prior to ignition. Comes under the heading of Dry Goods in the Sears catalogue.

Those Incomparable Computers

The C-E-I-R 7090 electronic computer recently demonstrated the translation from Russian to English at 60,000 words an hour, using an article from the Russian newspaper *Pravda* as the example. The machine also did a portion of the same article into German to show its versatility. Machine Translation Inc. designed and developed the translation system. Now, if the computer can be primed to distinguish between fact and fiction while translating!

No Casual Cushioning

After eight years of research, a survival automobile has been designed by Liberty Mutual, with twenty excellent features to increase driver-passenger safety. No. 20, "arm rests to reduce fatigue," seemed a little far-fetched until we figured that it is obviously safer for nervous passengers to grip arm rests instead of door handles, and consequently less fatiguing for the driver, who is relieved of some resulting tension.

Breathes There a Mouse

The purchasing department at Lockheed Missiles & Space Co. received an order for a mouse, and after shopping around, as good departments do, procured one for 85 cents (we did not know the going price). Seems Mr. Mouse was recruited just to stay in a test chamber and breathe without "fresh air." He did so for eighty hours, simply because potassium superoxide placed in the chamber converted the carbon dioxide and water vapor products of his breath into oxygen, as needed. The mouse was then released—not in the front office we hope. The experiment possibly supplies an answer to one of the most important man-in-space problems.

Packing Your Bag?

If you are headed for business conventions scheduled at vacation spots (and, after all, it isn't your fault if the powers that be choose Miami Beach, Denver, or Las Vegas), you will be vitally interested in the news reported by *The Wall Street Journal* to the effect that Internal Revenue Commissioner Caplin has promised that his agents will not reject a businessman's convention expense-account claims just because the meeting is held at a "posh" resort. There is no jest, however, about the word "just."

Just Spread It

There is a new wall paint on the market which in the can, it was stated, has the consistency of mayonnaise. We would judge it to be faster running than jelly but slower than peanut butter.

COMPACT CATCHALL—Gil Wallis, of the ground systems group at Hughes Aircraft Co., is favorably comparing the new 4-inch diameter stainless-steel memory drum (right) developed by Hughes for use in military mobile electronic defense systems, with its 8-inch aluminum predecessor (left). Both store the same amount of data—286,000 bits of information. We always felt the hat size wasn't important.

The 1960 Golden Anniversary annual report of Norma-Hoffmann Bearings Corporation, Stamford, Connecticut, outlines the impressive progress resulting from their long range capital improvement program. By the careful selection of reliable capital equipment compatible with a comprehensive quality control system, Norma-Hoffmann customers are assured of a consistently fine quality product.

AN INDICATION OF PROGRESS AT NORMA-HOFFMANN

. . . Bryant Centalign® Grinders

Important factors in progressive statistical quality controlled production are the Bryant Model "C" Centalign Grinders shown here in the Norma-Hoffmann plant. Straight bores and precision bearing raceways are ground on the Centaligns with consistent accuracy . . . at record-breaking production rates.

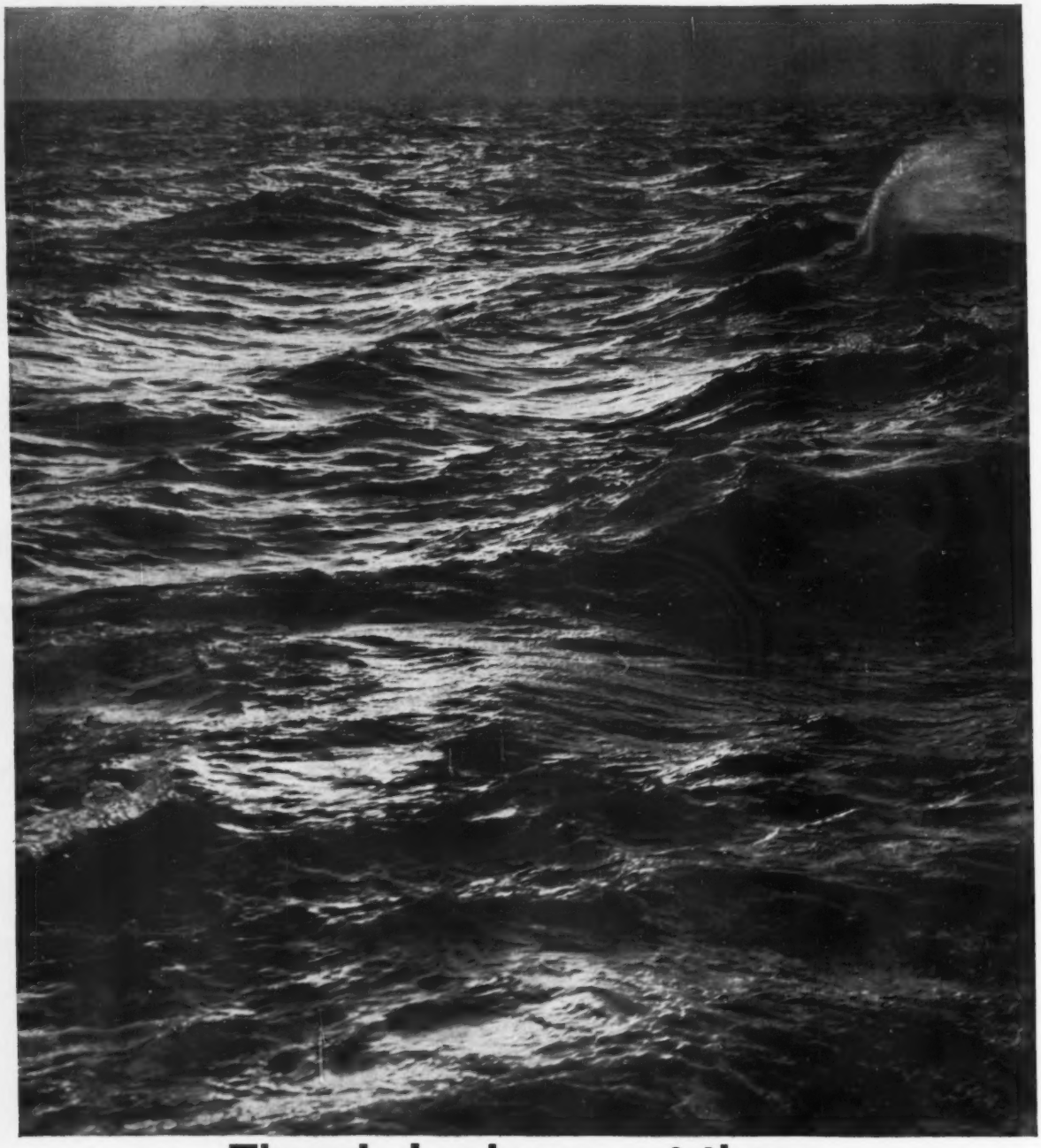
Progressive manufacturers throughout the world are improving their competitive position with Bryant Centaligns. Engineered for quick changeover and minimum down time, every one is thoroughly "proved out" at Bryant by statistical quality control methods. Find out how a Centalign Internal Grinder can help you.

BRYANT

Chucking Grinder Co.

20 CLINTON STREET, SPRINGFIELD, VERMONT, U.S.A.

Internal Grinders • Special Machinery



There's business out there.

You're looking at more than a horizon. It's a future, yours and America's. Out there is Europe and Latin America and Asia and Africa. But in 1960, of all U.S. manufacturers, less than 5% saw these foreign shores for what they are worth: a 19-billion-dollar export market, a vast source of foreign trade.

Move in for your share. Build your business and help keep America growing. Extra production creates more jobs, helps balance the outflow of gold, and wins new friends abroad with U.S.-made products.

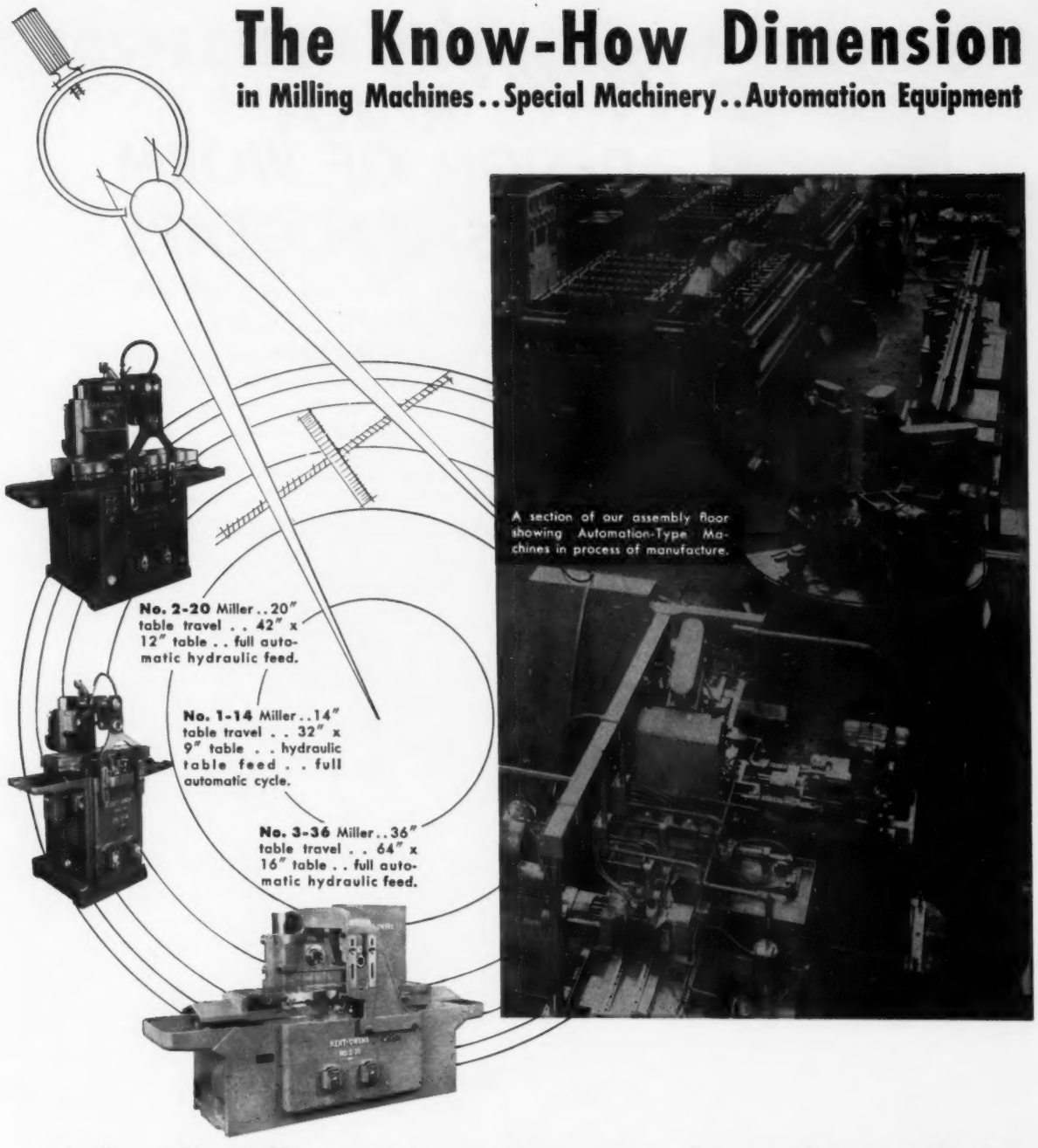
Even if you've never sold overseas, you have a rare opportunity to start—now. Your U.S. Department of Commerce will help with counsel by experts on what, where and how to sell—with data on credits, payments and financing. A package of invaluable know-how is yours for the asking.

Now's the time to discover the many ways in which your business can grow. In the lucrative export markets. In new U.S. markets. In developing new products. In attracting new industry to your community. Just write or phone the U.S. Department of Commerce Office of Field Services in your city, or Washington 25, D.C. They are ready to help you grow with America!

NOW'S THE TIME TO GET GROWING IN A GROWING AMERICA!

The Know-How Dimension

in Milling Machines . . Special Machinery . . Automation Equipment



A section of our assembly floor showing Automation-Type Machines in process of manufacture.

No. 2-20 Miller . . 20″ table travel . . 42″ x 12″ table . . full automatic hydraulic feed.

No. 1-14 Miller . . 14″ table travel . . 32″ x 9″ table . . hydraulic table feed . . full automatic cycle.

No. 3-36 Miller . . 36″ table travel . . 64″ x 16″ table . . full automatic hydraulic feed.

. . makes the difference in cutting costs . . increasing production

Know-How, born of years of experience, abetted by sound and imaginative design and quality manufacturing standards . . . is the reason why many of our customers, representing a wide and diversified coverage of industry, come back to us again and again for *answers* to their production problems.

When you are considering procurement of machinery for your milling needs . . . or seeking the solution to other production problems . . . you may wish to consider a Kent-Owens Milling Machine or a Special Machine designed for a distinctive and individual application. Contract Machine Building (customer designed equipment) is another of our specialties.

Write or call . . . Kent-Owens will be pleased to quote your requirements. Kent-Owens Machine Company, Toledo 10, Ohio.

KENT-OWENS *Designers and Builders of Milling Machines and Special Machinery*

New!

DESIGN OF WORM AND SPIRAL GEARS

by Earle Buckingham, *Professor Emeritus, Massachusetts Institute of Technology; Gear Consultant*
and
Henry H. Ryffel, *Gear Consultant, Superior Manufacturing & Instrument Corp.; Associate Editor, MACHINERY's HANDBOOK*

Answers Questions Like These

HOW DO YOU . . .

- design fine-pitch worms for indexing?
- design worm and spur gear drives?
- design spiral and worm drives with shafts at less than 90 degrees?
- design critical worm gear drives?
- calculate acceleration and dynamic loads?
- determine radiation of heat and oil cooling?
- determine mechanical efficiency of spiral and worm drives?
- replace spiral gears with a worm drive?
- use diametral pitch worms for high speed and small reduction ratios?
- design housings?
- mount worms and worm gears?
- design built-up worm gear blanks?
- use small screw threads as worms?

WHAT IS KNOWN ABOUT . . .

- the effect of all-recess action on coefficient of friction?
- the use of torsion bars to reduce dynamic loads?
- lubrication, friction, and wear?
- influence of position of pitch plane on contact between worm and gear?
- the misuse of the hunting tooth?
- relation of pitch surface forms to axes of gears?
- influence of misalignment on the forms of pitch surfaces?

WHAT IS THE NATURE OF . . .

- contact conditions of spiral gears?
- contact on enveloping worms?
- conjugate gear tooth action on worm drives?
- load distribution across the face of worm gears?
- limits of conjugate gear tooth action?
- axial thread forms produced by different methods of cutting?
- effect of pressure angle on contact of worm gears?
- effect of lead angle on contact worm gears?
- effect of diameter on contact of worm gears?

WHAT PROCEDURES ARE USED TO . . .

- design a complete spiral gear drive?
- design a complete worm gear drive?
- make an analysis of bearing loads for spiral and worm gear drives?
- make a graphical contact analysis?
- make an analytical contact analysis?
- determine the line of zero pressure angle?
- design for specified center distances?
- develop a practical series of speed-reducing worm drives?
- design step-up drives?
- design spiral gears by geometric similarity?
- determine center distances for all-recess action?

---------- ORDER FORM ----------

THE INDUSTRIAL PRESS, 93 Worth Street, New York 13, N.Y.

YES! Rush me ..... copies of "DESIGN OF WORM AND SPIRAL GEARS" @ $15.00. ☐ Check or money order enclosed. Send book postpaid.

☐ I will send payment plus 15¢ if I keep the book.
☐ Bill Company
☐ Bill me Orders from outside US—except Canada—add 50¢

Name .....
Company ..... NO. & ST. .....
City ..... Zone ..... State .....

0233

INSPECTION PROJECTOR MAGNIFIES FOR ® QUALITY...

Our inspection projector magnifies cutting edges to eliminate the minute angular deflection that could cause you costly production losses . . . just one of many inspections that account for Circle R quality.

CIRCLE R saws, slitters and combination center drills must submit to constant exhaustive inspection to work their way to you. They've got to prove they can ensure you correct cutting angles, long service, and minimal downtime.

Consult these CIRCLE R *Specialists . . .*

BURBANK
Production Mach. Sales Inc.
CEDAR RAPIDS
McNeal Tool & Supply Corp.
CHICAGO
Donald Robertson & Co.
CLEVELAND
Production Tool Co.
DAYTON
J. R. Kuntz Company
DETROIT
J. L. Bradford Associates
HACKENSACK
The Eaton Company
INDIANAPOLIS
Donald McIntire
MEMPHIS
Branch-Merwin Tool Specialists
MILWAUKEE
Ford Tool Company
MONTREAL
Humphrey B. Walton
NEW HYDE PARK
The Eaton Company
NEW YORK CITY
J. V. Cremonin (Export)
PHILADELPHIA
General Tool Sales Co.
PHOENIX
DiEugenio Tool Center
PITTSBURGH
Ralph Esposito & Co.
PROVIDENCE
Fred J. McMillen
ROCHESTER
James O. Horne

CIRCULAR TOOL CO., INC.

PROVIDENCE 5, RHODE ISLAND
Specialists in Circular Cutting Tools Since 1923

METAL SLITTING SAWS • COPPER SLITTING SAWS • SCREW SLOTTING SAWS • COMMUTATOR SLOTTING SAWS • JEWELERS' SLOTTING SAWS • CUT OFF SAWS • CIRCULAR KNIVES & ROTARY SHEAR BLADES • CIRCOLOY STEEL SAWS • SOLID & TIPPED TUNGSTEN CARBIDE SAWS • COMBINED DRILLS & COUNTERSINKS • CENTER REAMERS

For more data, circle this page number on Readers' Service Card

For Quality and Economy Use

MALLEABLE

For Service Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Alloy Foundries Division, The Eastern Co., Naugatuck

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division The Eastern Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
National Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

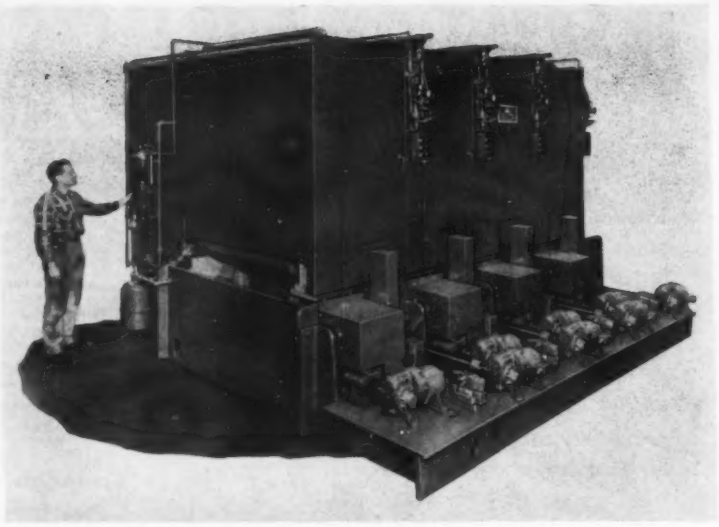
TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

These companies are members of the Malleable Castings Council

Circle page number on Readers' Service Card



Hill Acme multiple-head machine for grinding and polishing stainless-steel coiled strip stock

Multiple-Head Grinding and Polishing Machine for Coiled Strip Stock

A four-head grinding and polishing machine designed for the progressive finishing of stainless-steel coiled strip, which will process material 0.010 to 0.250 inch thick and 50 inches wide, has been brought out by the Hill Acme Co., Cleveland, Ohio. The entire unit is said to require only half the floor space occupied by four conventional strip grinders. The flexible design of the unit permits the addition of any number of grinding heads.

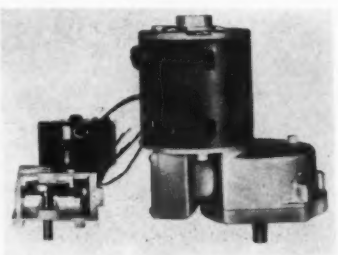
Each grinding head is composed of an endless abrasive belt running over a two-roll head with a motorized, adjustable steel billy roll for increasing the belt pressure against the steel strip. The belt on any head can be changed while the others are in operation. Rubber-covered guide rolls, built into the machine, create the proper "break" angle of the strip over each billy roll to flatten the strip at the point of contact with the abrasive belt.

For heavy stock removal, wet grinding is recommended with coolant supplied at the rate of 600 gpm. Sludge passes through the bottom of the machine to the filter units. Tests prove that considerably less strip material is lost than in previous methods. A built-in oil-mist spray system is used in finishing operations. The unit is equally efficient for either wet or dry operation.

Circle 594 on Readers' Service Card

Fractional-Horsepower Gear-Motors and Gear-Boxes

Subfractional horsepower gear-motors and gear-boxes for original equipment are now available with



Spiroid motors of 1/50 and 1/12 hp

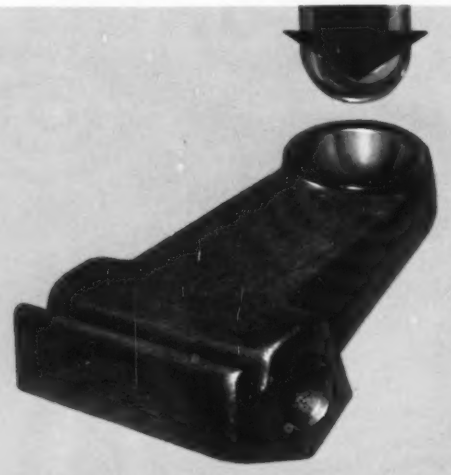
the Spiroid family of right-angle reduction gears from the Spiroid Division, Illinois Tool Works, Inc., Chicago, Ill. Single, double, and triple reductions can be made. Ratios range from approximately 4

Post-Forming: New Way to Bigger Savings with Malleable Castings

The ductility of Malleable iron castings permits use of high-speed forming techniques to finish Malleable parts at lower cost. Take advantage of the versatility you get only with ferritic and pearlitic Malleable castings. For a fuller understanding of how Malleable can help you, call any producer that displays this symbol —

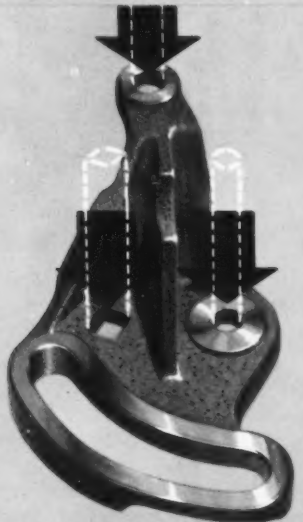
MEMBER
MALLEABLE
CASTINGS COUNCIL

Free Folder describing these techniques is available for your use. Just ask any member of the Malleable Castings Council for Data Unit No. 116, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.



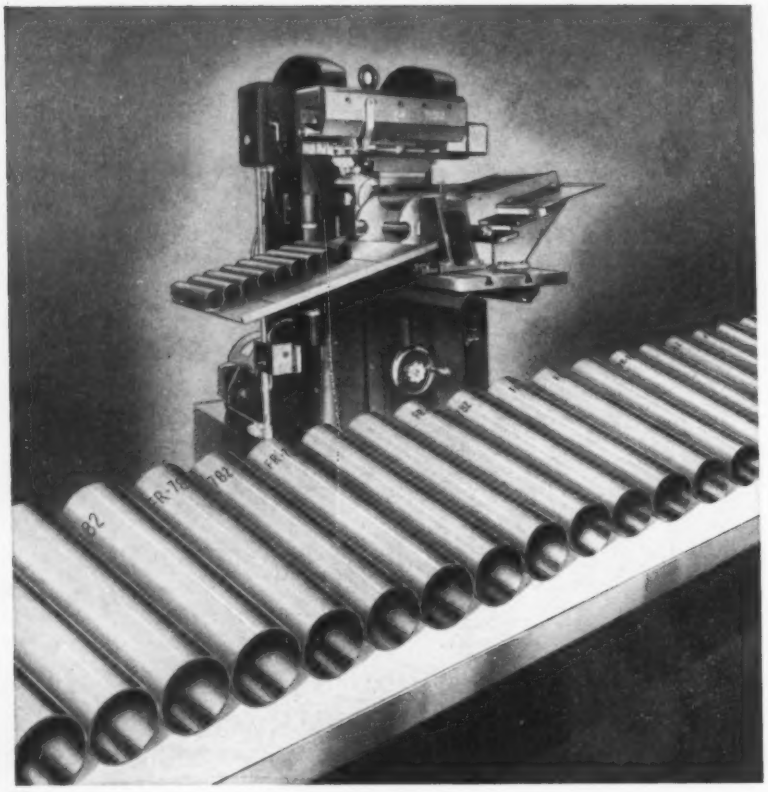
Hot Form It — Hot coining this Malleable transmission part reduces finished cost . . . eliminates three cutting operations required by the previously used steel part.

Roll It — Oil grooves in lawnmower crankshafts and splines in compressor crankshafts are just two of many places where rolling proves more economical than machining.



Punch It — Holes with diameters greater than the thickness of the metal can be punched in Malleable. Two round holes and a square hole are punched simultaneously in this idler arm.

Spin It — Malleable's ductility permits the sleeve and end disc in this ball joint to be held in place by spinning the Malleable housing into a strong, permanent flange.



AUTOMATED MARKING EQUIPMENT

EXAMPLE: OVER 3,000 TUBES PER HOUR

Here's a tough marking job—thin walled tubes would collapse under normal marking pressure. The problem was solved using a spider and reciprocating arbor type feed in a Model 175 . . . marking at a rate of 3,000 per hour.

Production marking of parts—any size or shape—is a Schmidt specialty. Why not call in a Schmidt engineer! He can help you plan a cost saving marking system.

COMPLETE LINE OF MARKING EQUIPMENT

Whatever you need in marking, GTS handles the complete job—dies, machinery and tooling. Let our marking specialists handle your problem. Send today for Catalog No. 18.

GTS SCHMIDT

IF IT'S WORTH MAKING, IT'S WORTH MARKING

GEO. T. SCHMIDT, INC.

Engraved Marking Tools • Nameplate Marking Equipment
Embossing Dies • Special and General Purpose Marking Machines

4102 N. Ravenswood • Chicago 13, Illinois • Phone: EA 7-0300

to 1 up to over 100,000 to 1. Greater strength, size for size, and quieter operation are said to be achieved by the use of Spiroid, Helicon, or Planoid gear sets, which have more teeth in contact than is possible with ordinary gears.

Permanently sealed, conventionally closed, or skeleton units can be designed for each specific application. Low-cost precision-machined housings are made from castings, extrusions, and stampings.

Circle 595 on Readers' Service Card

Portable, Transistorized Vibration Meter

A battery-operated, hand-carried vibration meter with high-gain, transistor circuitry is being introduced by the Korfund Co., Inc., Long Island City, N. Y. This is a self-contained instrument reading peak amplitudes of both absolute and relative vibrations directly on its large meter dial. It can be used wherever vibrations must be measured or monitored. Readings are in microns, over its

Vibration meter introduced by the Korfund Co., Inc.

5- to 1200-cycle-per-second frequency range. It has a measuring range of 0 to 1000 microns value (0.039 inch) in five steps, and a sensitivity down to 0 to 10 microns full scale (0.00039 inch).

In every range, internal calibration is available, permitting calibration of meter and transducer

SINGER*
NUMERICAL CONTROL

BUY THE COMPLETE PACKAGE . . . For the O.E.M., SINGER Numerical Control is the most direct approach to point-to-point positioning. It offers speed, capacity, versatility, and high accuracy, and is available at a low initial investment. The system is sold as a package, complete and ready for installation, including the tape reader. It requires only the measuring bars to suit the specific machine. SINGER Numerical Control offers a high degree of accuracy for drilling, jig boring or milling . . . ±.001 inch as standard or ±.0002 when required on work tables up to 40 inches in size. . . . **OR AUTOMATIC POSITIONING . . .** For the buyer who wants to acquaint himself with the advantages of automatic positioning with end measures, rather than buy a complete Numerical Control package, our system is ideal. Because of SINGER'S modular design, a machine can be furnished with the automatic positioning system only. At a later date, the tape portion of the system can be readily added with no sacrifice of the original investment. It is important to know, too, that all modules and motors are designed, serviced and built by Diehl Manufacturing Company, a SINGER subsidiary. Call or write for an appointment at the address below.

Diehl† **DIEHL MANUFACTURING COMPANY**

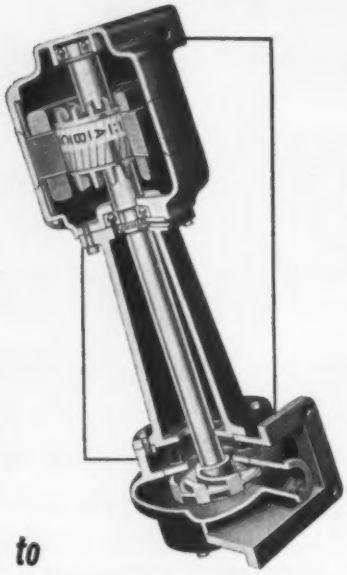
SUBSIDIARY OF THE SINGER MANUFACTURING COMPANY • Finderne Plant, Somerville, New Jersey • Telephone: Randolph 5-2200

*A Trademark of THE SINGER MANUFACTURING COMPANY
†A Trademark of THE DIEHL MANUFACTURING COMPANY

For more data, circle this page number on Readers' Service Card

Gusher

Coolant Pumps are PRECISION BUILT



to

- LAST LONGER
- PERFORM BETTER

ON YOUR MACHINES

You get better performance from your GUSHER Coolant Pumps because they are precision built. The one piece shaft in GUSHER Pumps is electronically balanced to cut vibration to a minimum. Ball bearings are pre-lubricated, no seal or packing needed. Write for catalog.

THE Ruthman MACHINERY CO.

• COOLANT PUMPS
• CIRCULATORS • AGITATORS
• MOLTEN METAL PUMPS

1807 Reading Road • Cincinnati 2, Ohio

Circle page number on Readers' Service Card

to a high degree of precision. Easy to handle, it weighs only 5 pounds and measures 9 1/2 by 5 by 4 inches.

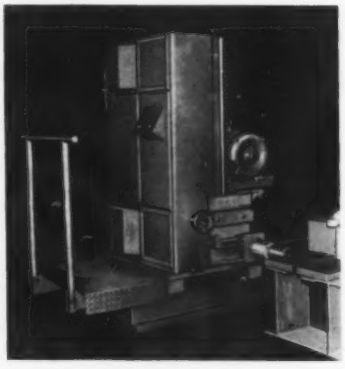
The meter permits machinery maintenance operations on a scheduled, rather than emergency, basis by comparing the vibration amplitude at installation with later readings. These comparisons, taken at regular intervals, establish the amount of wear in bearings or cutting tools, indicating when replacement will be necessary before breakdown occurs.

A special terminal for connecting the meter's output into an oscilloscope or high-speed recorder is provided for making permanent records. An additional input for pulses from a phase indicator enables phase measurements of rotating objects to be made, the signal impulse appearing on the scope's screen as a pip superimposed on the output voltage of the pickup.

Circle 596 on Readers' Service Card

Rojar Horizontal Mill for Structural-Steel Milling Operations

Futurmill, Inc., Southfield, Mich., has announced a Rojar low-cost milling machine specifically designed for milling columns, chords, beams, and other structural-steel shapes. This small, compact machine is manufactured



Rojar horizontal mill introduced by Futurmill, Inc.

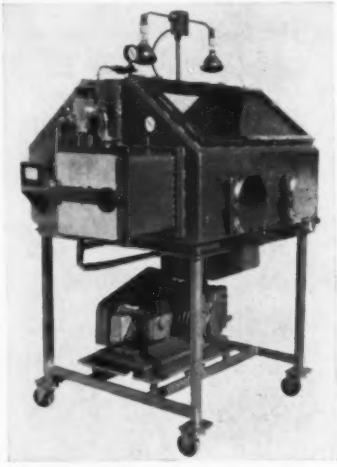
by the Rojar Corporation and is sold exclusively by Futurmill, Inc. It weighs only 4000 pounds, stands 72 inches high, and the standard length is 96 inches over-all.

The 15-hp spindle provides ample power for structural-steel milling applications. The machine has a 42-inch vertical travel, 66-inch horizontal travel (extended horizontal travel available), and 3-inch micrometer handwheel infeed. The standard spindle speed is 1200 rpm (changeable with belt and pully adjustment). All movements are controlled from convenient operator push-button panel.

Circle 597 on Readers' Service Card

Enclosure for Inert-Gas Welding of Rare Metals

An inert-gas welding enclosure, designated Eringard Model MK II, is announced by the Royal Research Corporation, Hayward, Calif. This unit—arranged as shown in the illustration—is designed for welding rare metals, such as molybdenum, tantalum, columbium, and zirconium, which oxidize readily in the presence of normal air. Selective inert gases can be used with this system. A low peak rate of less than 1 micron per minute, at a base pressure of 1 micron, assures maximum purity of the working atmosphere.

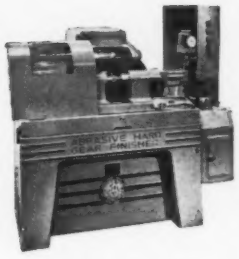


Eringard Model MK II inert-gas welding enclosure

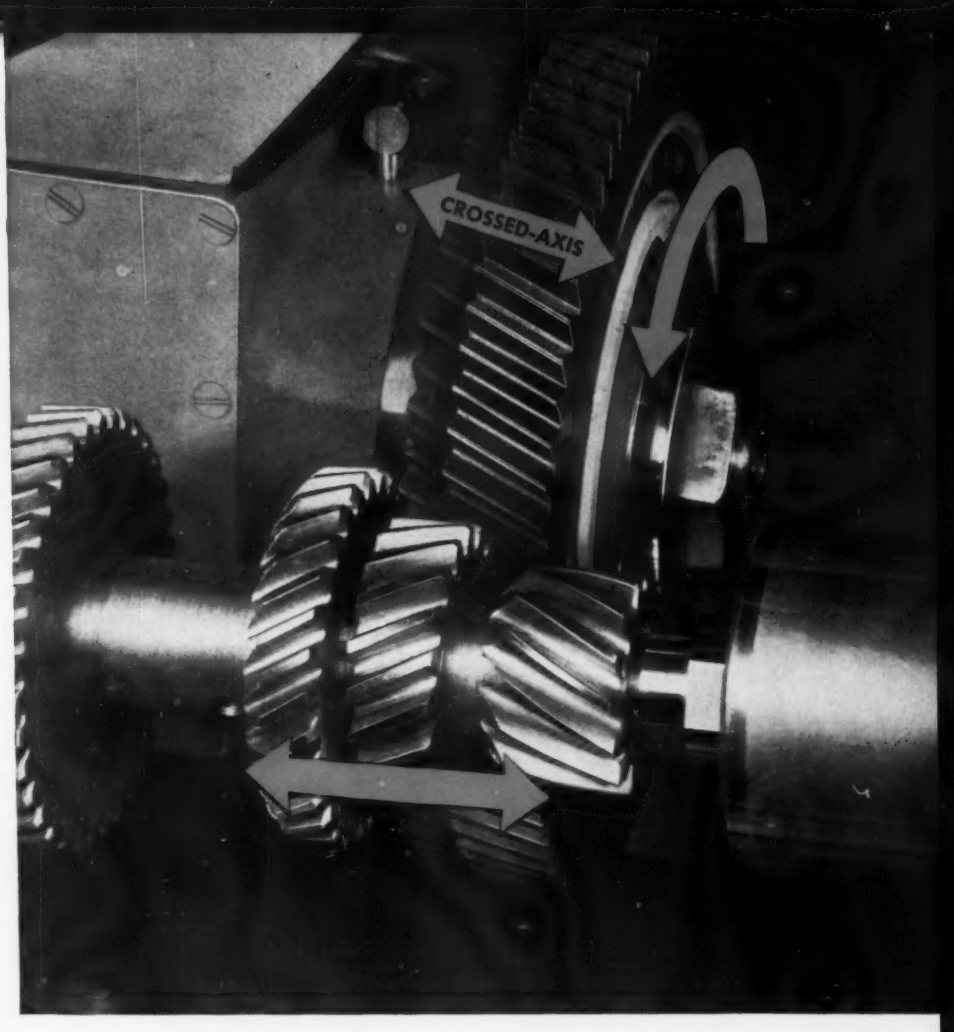
Of heavy steel-welded construction, the unit is equipped with four 8-inch diameter Erinseal glove ports that permit two operators to work simultaneously, either as a team or independently.

Circle 598 on Readers' Service Card

NEW



FOUR-MOTION GEAR FINISHING PROCESS GIVES...



TRUE HONING ACTION!

Smooth hone may be used to finish OD's in certain applications.

The new Michigan 999-A Abrasive Hard Gear Finisher uses four separate but integrated motions to give better surface finish on hardened gears and cylindrical parts. Nicks, burrs, some errors in lead and runout, involute, etc. are quickly corrected with newly developed hones of high-strength plastic available in a wide range of abrasives.

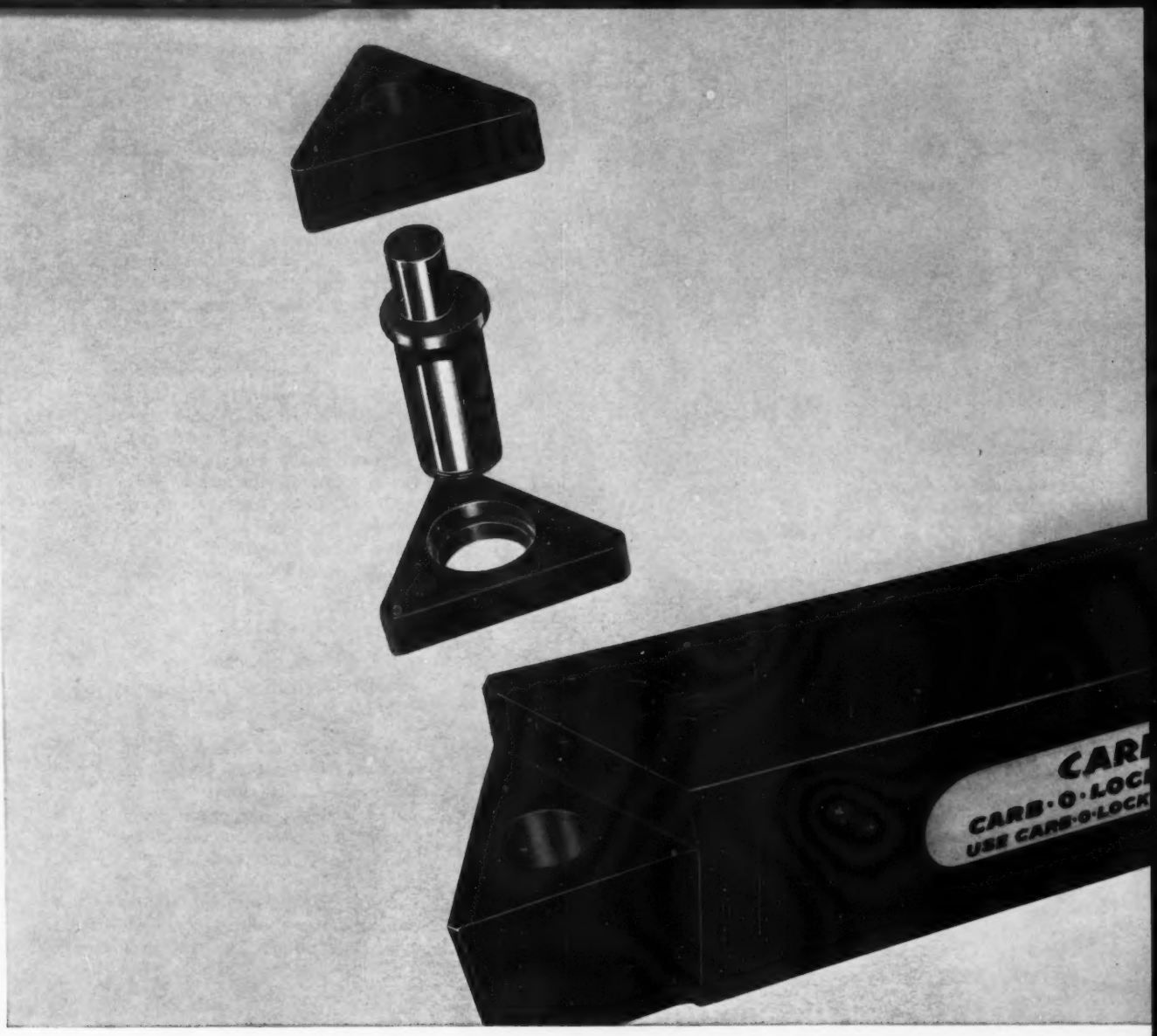
The hone (1) oscillates axially at high speed while (2) the work is reciprocated across the hone, (3) the gear is rotated—under controlled pressure—in mesh with the hone causing (4) sliding action due to crossed-axis of work and hone. This "Four-Motion" process results in smoother, quieter running parts.

Independently variable speeds and up to 25° hone head swivel will accommodate a wide variety of workpieces. Crowning-taper attachment, automatic loader, internal gear attachment and tool dresser are available as optional equipment. For full details write for Bulletin 999-A.

A head modification kit to convert Michigan Model 999 to the new process is available.

MICHIGAN TOOL COMPANY, 7171 E. McNICHOLS RD., DETROIT 12, MICHIGAN

How to cut your disposable-tooling costs by 30 per cent at no sacrifice in quality or output. (Answer is on the next page.)



With the new Carb-O-Lock toolholder-insert combination. The single most important advance in the whole history of metal-cutting.

Save 30 per cent when you buy it. Save 40 per cent when you use it.

These are minimums. Users of the Carboloy Carb-O-Lock toolholder-insert combination have reported savings many times higher. Why?

Simple. The Carb-O-Lock design is simple. Using a cam-action locking principle, the Carb-O-Lock has just three parts (not including insert). Insert changing and indexing is a breeze; parts inventories can be held to absolute minimums. Streamlined design lets you bring the toolholder closer to your work. And less overhang means less vibration, less insert chipping and breaking.

Plus: the Carb-O-Lock gives you proven performance. A major diesel engine manufacturer discovered Carb-O-Lock allowed nearly triple the feed, eliminating two machines. A locomotive and car equipment company found Carb-O-Lock's simple, rugged design reduced time for tool changes and permitted maximum horsepower utilization.*

Carb-O-Lock inserts are available now in Grade 883 for machining cast iron, as well as many operations on the following materials: high-temperature alloys, type 300 stainless steel, brass, bronze.

So start your savings program today. Phone your Authorized Carboloy Distributor and order your Carb-O-Lock toolholder-insert combination. Save 30 per cent. And more.

Metallurgical Products Department of General Electric Company, 11147 E. 8 Mile Road, Detroit 32, Michigan.

**Case histories available on request*

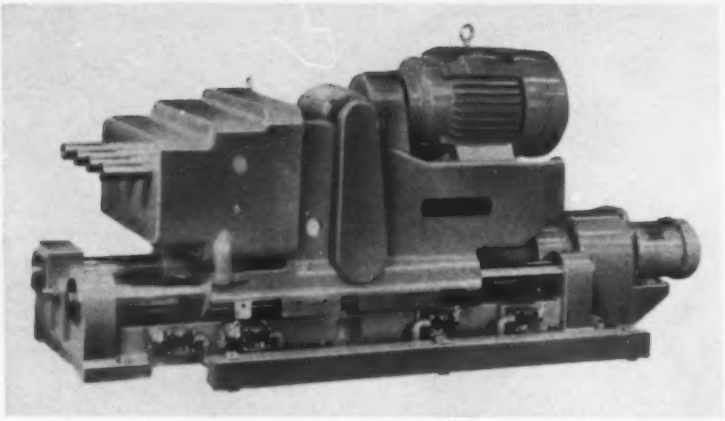
CARBOLOY
CEMENTED CARBIDES

METALLURGICAL PRODUCTS DEPARTMENT

GENERAL ELECTRIC

CARBOLOY CEMENTED CARBIDE BLANKS AND DISPOSABLE INSERTS • BRAZED TOOLS • TOOLHOLDERS • CARBIDE DIES • WEAR PARTS

For more data, circle this page number on Readers' Service Card



Lead-screw unit head of versatile design announced by the Foote-Burt Co.

Footburt Lead-Screw Unit Head with Positive Stop for Feed

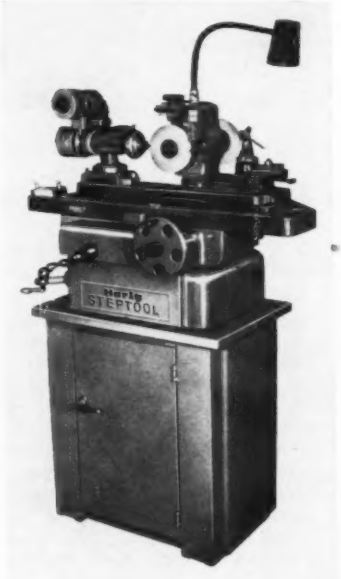
The Foote-Burt Co., Cleveland, Ohio, has announced a positive-feed electromechanical lead-screw unit for drilling, boring, reaming, counterboring, spot facing, chamfering, milling, and trepanning. This is said to be the first time a machine builder has offered a choice of hydraulic, cam-feed, or lead-screw power units on its equipment. A recirculating-ball type precision lead-screw feed mechanism promises both higher production rates and decreased maintenance, as well as improved product quality. There are no delicate or complex components to wear out or break. Accurate, positive feed is provided. It is claimed to be the only mechanical-drive unit designed to feed against a positive stop and provide adjustable tool dwell.

Spindle drive, rapid traverse, and feed are provided by separate motors. The rapid-traverse motor drives the lead-screw; the feed motor drives a recirculating-ball nut. An adjustable-torque brake permits feeding against a positive stop through controlled slip. The brake can be calibrated to slip at a preset overload, guarding machine, tools, and work-piece against damage. The spindle-drive motor is unencumbered by "power take-offs" for the feed and traverse mechanism. The standard rapid-traverse rate is 280 ipm.

Circle 599 on Readers' Service Card

Dual-Purpose Relief-Grinding Machine Points Drills

A floor-model relief-grinding machine that performs both as an ultraprecise drill-point grinder and versatile cam type relief grinder has been announced by Harig Mfg. Corporation, Chicago, Ill. As a drill-point grinder this machine grinds original points and resharpens virtually every style drill point. This includes



Harig dual-purpose relief-grinding and drill-pointing machine

precision pointing
MEANS PRECISION DRILLING

. . . a must for top efficiency

the
fast, automatic
WINSLO-MATIC DRILL POINTER

Write for FREE Literature

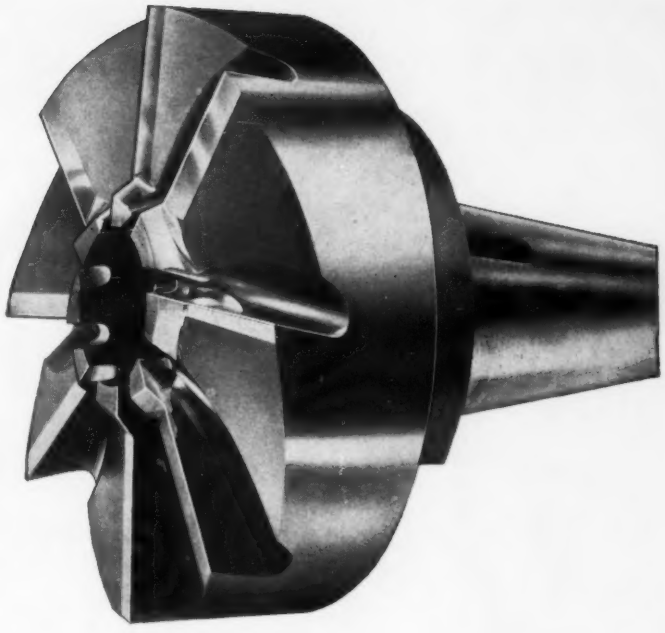
Drills sharpened on the WINSLO-MATIC Drill Pointer are concentric within .0002". They produce up to twice as many precision holes within .001 of drill size (even in the new super metals). This precision pointing provides other benefits too. Faster drilling. Fewer rejects. Elimination of most reaming requirements.

The WINSLO-MATIC Drill Pointer handles drills from 1/32" to 1½" diameters. Produces conventional chisel-type points as well as helical (self-centering) points for optimum performance on tape controlled drilling machines. Also sharpens taps, center drills and core drills.

Whether you use conventional manufacturing methods or numerically controlled machines . . . it's good business to make the WINSLO-MATIC Drill Pointer a part of your operations.

Winslow PRODUCT ENGINEERING CORPORATION
47 ST. JOSEPH STREET • ARCADIA, CALIFORNIA

RETURN
ON YOUR MACHINE
INVESTMENT
DEPENDS ON THE
CUTTER YOU USE
HERE *



Illinite® Job-Tailored Milling Cutters do more work . . . cut costs

The more a milling machine and operator time costs, the more important the right milling cutter becomes. Upon it rests the responsibility not only of output, but profits.

That's why so many major manufacturers with heavy investment in production equipment are turning to Illinite Job-Tailored Milling Cutters after a cost analysis review of their (present or planned) production milling operations.

Illinois Tool Works' nearly 50 years of specialization in job-tailored production tool engineering—with emphasis on design, forging, heat treating and material selection—brings these cost cutting benefits to you.

The new ITW guide to Milling Cutter application evaluation and cost analysis will help you plan optimum production milling programs. See how this analysis, along with helpful hints to better milling, can improve your operation. Get your copy now; you'll be glad you did.

Send for your copy

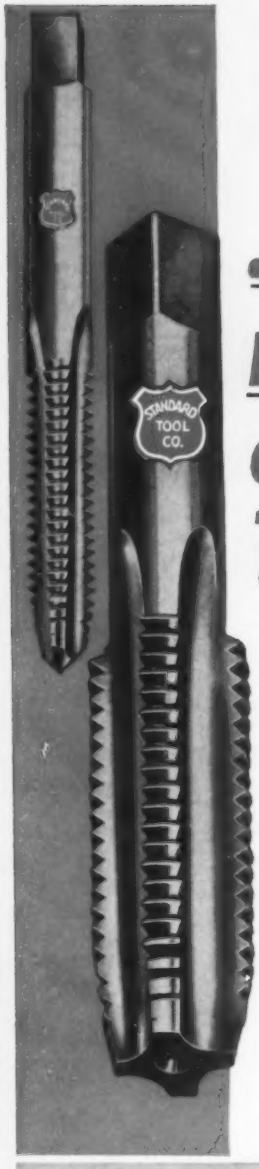
This cutting tool performance evaluation form helps you quickly set down the facts concerning your production milling application. Whenever possible make this analysis before expensive production begins. Your ITW representative will help you.

itw **ILLINOIS TOOL & INSTRUMENT**
DIVISION ILLINOIS TOOL WORKS INC.
2501 N. KEELER AVENUE, CHICAGO 39, ILLINOIS
In Canada: CITCO DIVISION, CANADA ILLINOIS TOOLS, Ltd., Don Mills, Ontario

For more data, circle this page number on Readers' Service Card

MORE metal removed at LESS COST

Standardize with STANDARD'S Quality



...Controlled manufacture of STANDARD'S TAPS...assures these PLUS Features!...

1 All flutes are Index ground.

2 Flute contours, Hook and Rake Angles Constant, One Tap to another.

3 Concentric on all lands—no high or low cutting edges.

4 Shanks, outside diameter, pitch diameter and chamfer all in perfect concentricity.

DEPEND upon STANDARD'S Authorized Distributors . . .

For Twist Drills, Reamers, Taps, Counterbores, End Mills, Milling Cutters, Hobs, Gages, Dies, Carbides (solid or tipped) . . . and for Engineering or Technical Information.

STANDARD TOOL CO.

3950 CHESTER AVENUE CLEVELAND 14, OHIO

BRANCH WAREHOUSES IN: NEW YORK · DETROIT · CHICAGO · DALLAS · LOS ANGELES · SAN FRANCISCO

split crankshaft points, Helixpoints or spiral points, as well as chisel or conventional points. It will grind three- and four-lip coredrills and points for drilling exotic metals, printed circuits, and sheet metal.

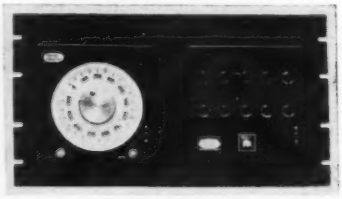
Indexing and concentricity accuracy are in 0.0001 inch. Changeovers to different sizes, angles, and styles are accomplished in seconds. Web thinning and split points are done on a separate independent slide adjacent to a second grinding wheel. This machine is intended for users of mixed varieties of tools or for continuous production.

As a cam relief grinder the versatility of the machine is extended to the rapid grinding, with eccentric relief, of such basic tools as step drills with or without marginal relief, taps, countersinks of every style including uniflutes, center drills, double margin drills, subland drills, porting and valveseating tools, and special tools with forms and contours. Sharp corners on step drills within 0.001 inch and with no undercut are accomplished by a unique system of grinding above center which permits the use of large-diameter grinding wheels for this formerly difficult class of work.

The range of work performed is from 1/64 through 1 1/32 inches, left- or right-hand. There is no limit to flute numbers. A full set of sixty-six precision collets specially designed for gripping on flutes comes with the machine. An additional optional headstock converts the machine to an all-around end-mill and milling-cutter sharpener.

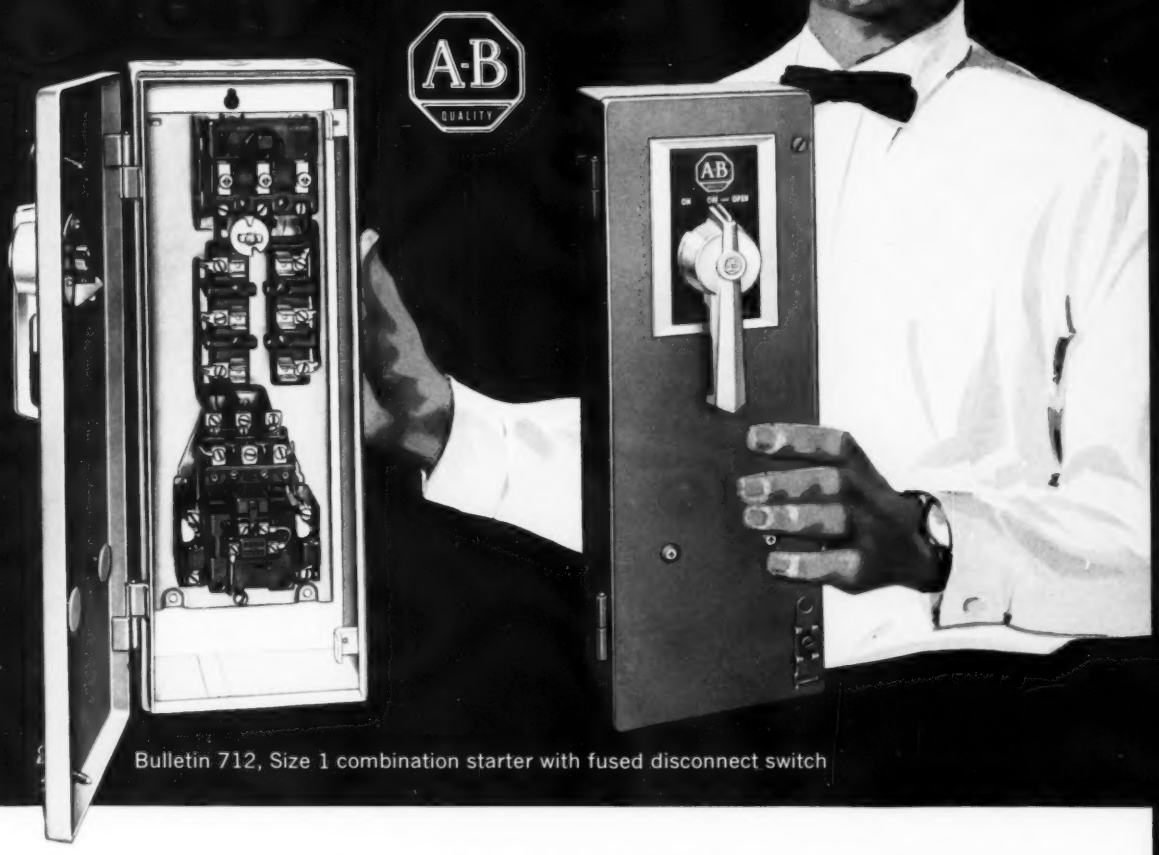
Circle 600 on Readers' Service Card

Thermo-Electronic "Economy Monitor"



Thermo - electronic "Economy Monitor," developed by Thermo Electric Co., Inc., Saddle Brook,

Let me tell you why these NEW BULLETIN 712 and 713 Combination Starters should interest you!



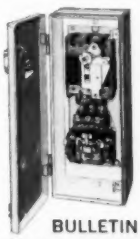
Bulletin 712, Size 1 combination starter with fused disconnect switch

They have — Smaller Size...Greater Switching Capacity... Greater Reliability...Longer Life...Complete Safety... Generous Wiring Room...Simple Design...Businesslike Beauty

Rating for rating, the new Bulletin 712 motor starter will outperform and outlast all others. Complete safety for the operator is assured because the cabinet door cannot be opened until the lever is moved to the OPEN position, which opens the visible contact disconnect switch.

The Bulletin 713 combination starter provides similar features for complete safety, but uses an ITE circuit breaker as a method of disconnecting.

Brooks Stevens, famous industrial designer, has given the entire line of enclosures, an undeniable "eye appeal"—an asset to any modern machine tool or industrial installation. Please write for details, in Publication 6100: Allen-Bradley Co., 1316 S. Second Street, Milwaukee 4, Wis.



BULLETIN 713
Combination Starter with Circuit Breaker in Nema Type 1 Enclosure.

19-61 RM

ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL

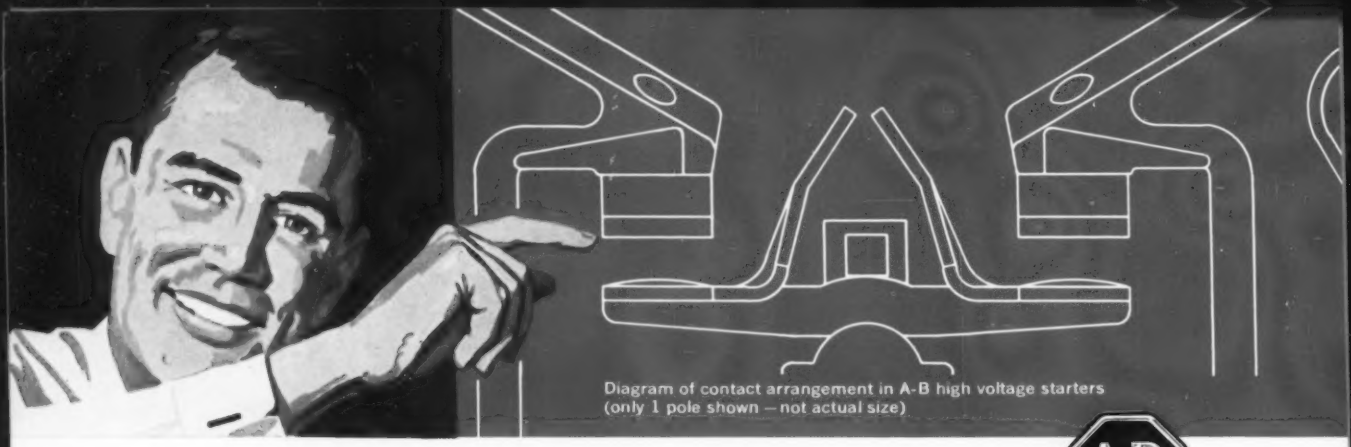


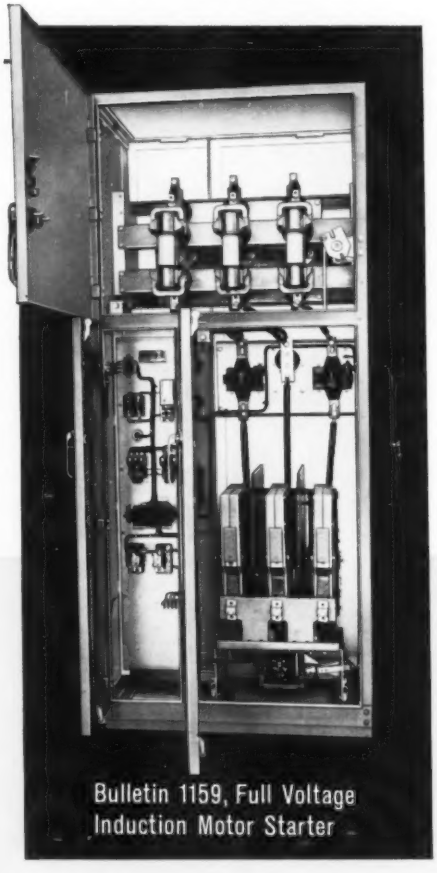
Diagram of contact arrangement in A-B high voltage starters
(only 1 pole shown — not actual size)

Would You Believe That

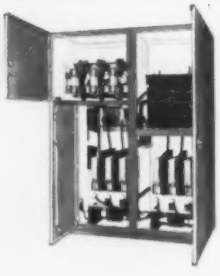
3/8 OF AN INCH IS THE REASON

for the Reliability and Long Trouble Free Life of A-B Starters Rated at 1500 hp, 2300 v; 2500 hp, 4600 v!

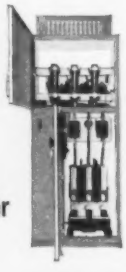
Allen-Bradley high voltage starters were designed and are built to provide millions of trouble free operations. An astounding claim—for this class of apparatus—but *true!* The extraordinary performance of the air break contacts is the result of extremely short contact travel—only 3/8"! Naturally, such short travel reduces pounding and contact wear to a minimum. Also, the famous Allen-Bradley solenoid principle of operation is so simple that nothing can go wrong. Maintenance-free, double break silver alloy contacts are used throughout. Allen-Bradley high voltage starters are available for all types of motors and all types of service. For full details please write today for Bulletin 6080 to: Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin.



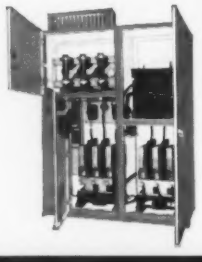
Bulletin 1159, Full Voltage
Induction Motor Starter



Bulletin 1172, Reduced Voltage
Induction Motor Starter



Bulletin 966, Full Voltage
Synchronous Motor Starter



Bulletin 983, Reduced Voltage
Synchronous Motor Starter

19-61-RM

ALLEN-BRADLEY

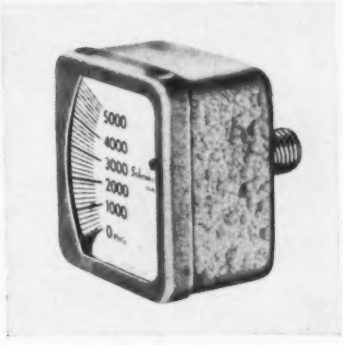
QUALITY
MOTOR CONTROL

N. J., to provide accurate, sensitive, low-cost monitoring of one to ten points, to be checked for the same value. Applications include monitoring temperature, pressure, speed, flow, etc., or any process variables measurable by transducers generating direct-current millivolt outputs, or changes in resistance. Each point to be monitored is scanned in sequence and its value is compared to a preestablished set point. Ten red lights on the face of the instrument indicate scanning position. High or low deviation from set point at any of the monitored points will cause a visual indication of malfunction, and shut down the process or processes involved.

Circle 601 on Readers' Service Card

Schrader Direct-Action Hydraulic Gages

One of a line of compact hydraulic gages, calibrated in four pressure ranges, announced by A. Schrader's Son, a division of Scovill Mfg. Co., Inc., Brooklyn, N. Y.



Designed to provide dependable, accurate service and long cycling life, these rugged units operate on the positive direct-action principle. The spring-loaded pressure-sensing mechanism is protected from shock damage and pressure overloads by a built-in dampening device. A positive stop insures a continued high degree of accuracy, even when used under severe conditions. Available in four ranges: from 0 to 500, 1500, 3000, and 5000 psi.

Circle 602 on Readers' Service Card

Nobody, but nobody, tends your die set needs with such dispatch as Danly. Whether you want a new Precision Pilot Guide Post for extra ease in die set assembly . . . or a fast order placed for a special die set, you can depend on your nearby Danly man for quick, effective action. Like all 23 Danly branches and distributor assembly plants, he stocks a wide selection of die sets and diemakers' supplies for immediate delivery. Next time you need die set service, call your Danly man. He's as close as your phone—and at your service 'round the clock.

DANLY®

NEW INSULATED Demountable Bushings, designed for use in machining mounted dies by electrical discharge, are fully described in new, fact-filled bulletin. Write for your copy.

Mechanical Presses, Die Sets, Diemakers' Supplies, Hydraulic Metalworking Equipment

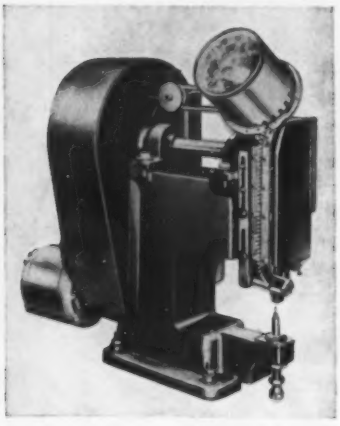
DANLY

DANLY MACHINE SPECIALTIES, INC., 2100 South Laramie Ave., Chicago 50, Illinois

For more data, circle this page number on Readers' Service Card

Tubular Riveting Machine

Machine brought out by Eyelet Tool Co., Inc., Cambridge, Mass., for high-production, heavy-duty



tubular riveting in the electrical, electronic, and metal fabrication industries. Can also feed and fasten all makes of eyelets and grommets. A setting force in excess of 3000 foot-pounds is available through 40-pound flywheel.

Circle 603 on Readers' Service Card

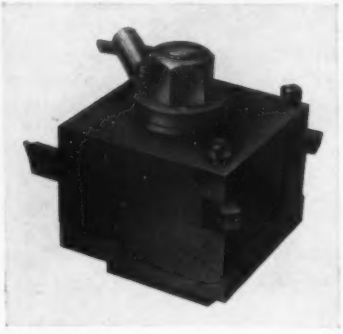
Hef-Co Step Blocks

Quick-adjusting step block made of cold-roll steel plates finished by zinc plating brought out by Hef-Co., Cleveland, Ohio. Heights can be adjusted in increments of 1/8 inch and clamped by means of a simple wing-nut. Available in 2- and 3-inch heights. Base is 1 1/2 by 2 inches. Said to cut setup time in half by taking place of scrap shims and blocks ordinarily used in clamping work on drill press, punch press, milling machine, grinder, and various other machines.

Circle 604 on Readers' Service Card

Koning "5 in 1" Tool-Holder

Versatile tool-holder designed to do the work of five conventional holders in performing lathe operations announced by Koning Machine & Tool Co., Holland, Mich. This holder is machined to fit all lathes and to accept standard-size cutting tools in three positions, boring-bars, and parting blades. All tool openings are hardened.

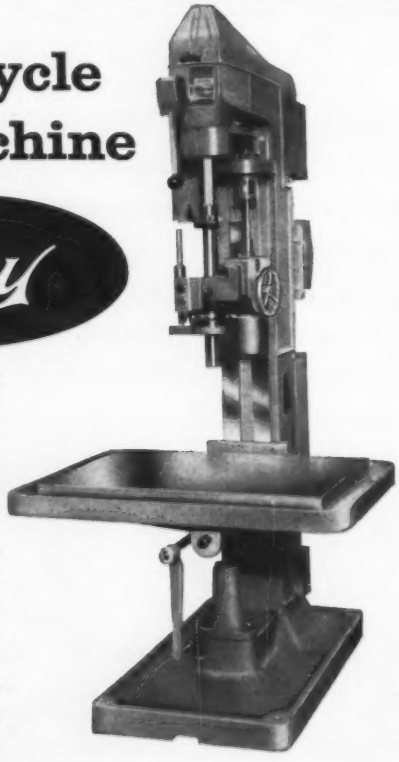


An exclusive rocker base permits accurate positioning of the tool in relation to the center line of the work, eliminating wasteful trial-and-error shimming of tools.

Circle 605 on Readers' Service Card

automatic cycle drilling machine

Avey



You can chop your time costs with automatic set-ups on this new Avey machine, and still take advantage of the low cost and flexibility of a standard unit. Adjustable rapid power traverse, feed, and rapid return of the spindle permit automatic transfer or rotary index fixturing. You also get adjustable feeds, speeds, table travel, head travel, and Avey's precision spindle. Morse Taper 2, 3, or 4; single or multiple spindles 1 to 5 hp. *Write or phone for data.* Avey, Box 1264, Cincinnati 1, Ohio.

Scott Sound-Level Meter

Sound-level meter designed to operate over an exceptionally wide frequency range made by H. H. Scott, Inc., Maynard, Mass. Ce-

ramic microphone allows use in wide temperature range. Built-in electroacoustic calibrator insures consistent accurate readings at all times. Operates on two batteries plus a single bias cell.

Circle 606 on Readers' Service Card

THIS CINCINNATI®
shears heavy plate

Paragon Bridge & Steel Co., Novi, Mich., cuts costs as it cuts heavy plate with this Cincinnati Shear:

Operators cut production time with rapid, easy gaging and adjustment; no need for changing knife clearance to cut different thicknesses of metal.

The Cincinnati Shear also permits square shearing, notching, and slitting operations.

This machine can trim an edge to one-half the thickness of a sheet or plate. Furthermore, longer knife life is obtained from extra-size, four-edge knives.

Whether you're considering a mechanical or hydraulic shear, the broad Cincinnati line offers you maximum advantages for your plate shearing requirements. Write for your copy of a Cincinnati Shear catalog.

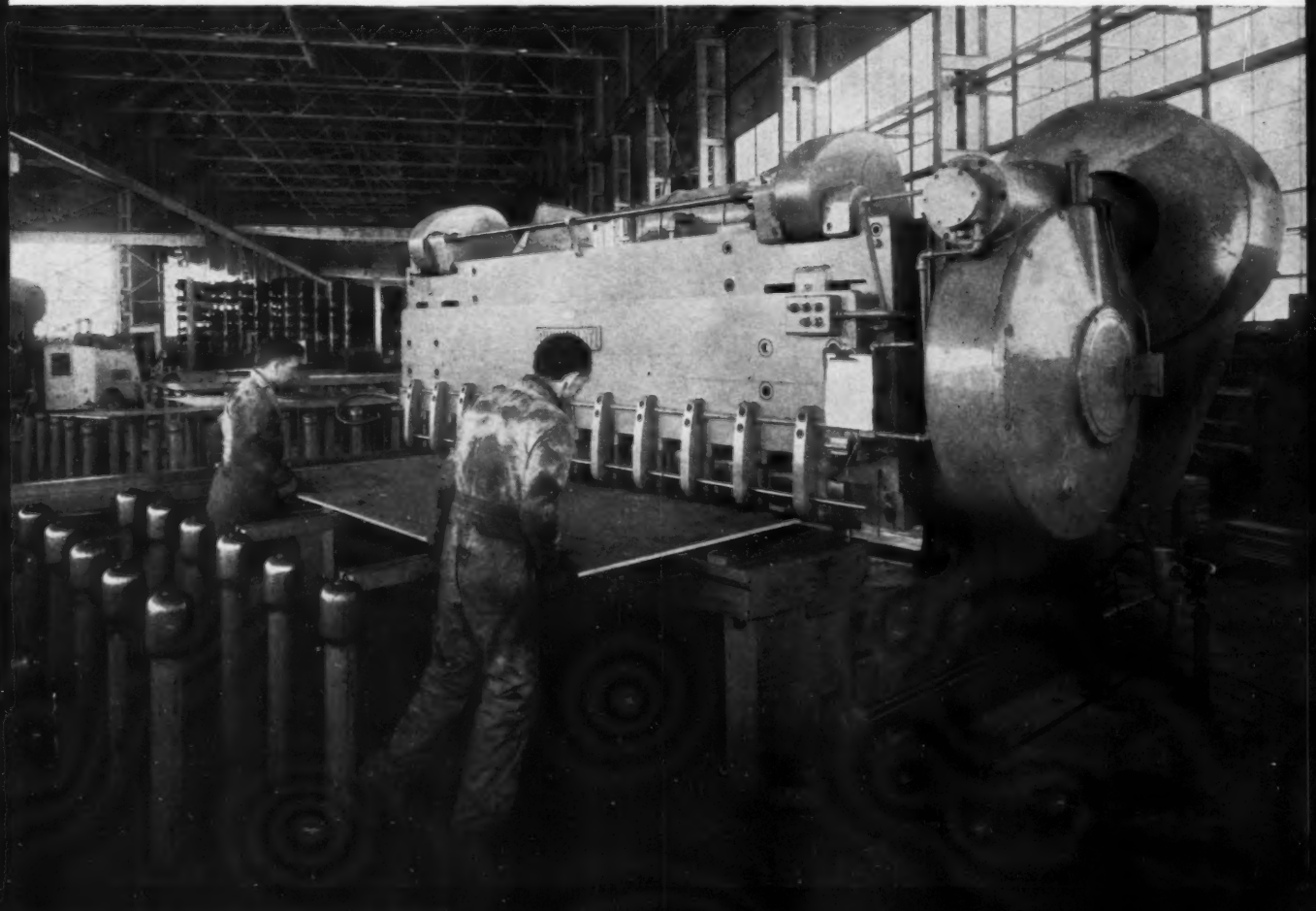
Shapers / Shears / Press Brakes

THE CINCINNATI SHAPER CO.

Cincinnati 11, Ohio, U.S.A.

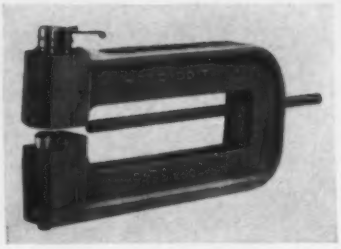
United Kingdom: The Cincinnati Shaper Co., Ltd., Glasgow, Scotland

Courtesy Paragon Bridge & Steel Co., Novi, Mich.



Gage Rods for Strippit Self-Contained Units

Self-contained punch unit made by Wales Strippit Inc., Akron, N. Y., equipped with positive-locking, threaded gage rod. Gage rods of this kind are now being furnished as accessories for many of the company's self-contained sheet-metal punching and notching units. A tapped hole is provided in the holders of the BN-3/4, BN 1 1/4 (illustrated), CJ-1, and CJ 1 3/8 units. The gage rods can be accurately adjusted and



then securely held in place with a lock-nut. They are now available as accessories for the units listed above.

Circle 607 on Readers' Service Card

17,600 HOLES DRILLED, C' SUNK AND TAPPED IN SINGLE JOB

Meridian Metalcraft, Inc., Whittier, California, uses two power-fed, specially tooled Burgmaster Bench Model Turret Drills to increase production 200% in the drilling, c'sinking and tapping of 176 holes in a webbed-core dissipator plate . . . 100 plates to a run. A Burgmaster unit is mounted on the frame of an old rivet machine to get added throat depth and speed. Flat sides are machined on this unit. The other Burgmaster unit is equipped with a trunion mounted fixture for fast indexing of holes machined in opposing edges of the plates. Hole locations are held to .002". The Burgmasters replaced ten single-spindle drills and reduced floor space. Some salient reasons why you shoud get the facts on the Burgmaster.

SEND FOR LITERATURE

Burgmaster CORPORATION

SMALL TOOL DIVISION
15001 S. Figueroa Street, Box 311
Gardena, California, Phone FAculty 1-3510

Armstrong Ratchet Wrenches

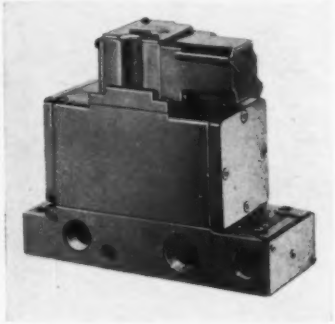
Reversible "90" series ratchet wrenches available in 1/4-, 3/8-, and 1/2-inch square drives, with

two handle lengths in the 1/2-inch drive, from Armstrong Bros. Tool Co., Chicago, Ill. Features include a narrow head, round handle with hole for hanging, thumb-operated reversing lever, ball-and-spring reversing lever stop to prevent accidental shifting, fine-toothed gear, easy ratcheting action, and simplified cleaning. All wearable parts can be individually replaced at low cost.

Circle 608 on Readers' Service Card

Hannifin Pilot-Operated Air Valves

Four-way, high-speed, high-capacity, pilot-operated air control valve of new line offering both momentary and maintained contact electrical actuation models announced by Hannifin Co., a di-



vision of Parker-Hannifin Corporation, Des Plaines, Ill. These Series "HH" air valves have plug-in type, low-wattage continuously rated solenoids for most popular alternating- and direct-current ratings. They are offered in 3/8-, 1/2-, and 3/4-inch pipe sizes with side ported bases as standard, and a wide variety of other porting arrangements.

Circle 609 on Readers' Service Card

Spindle Speeds	INFINITE (from 43 to 3500 RPM)
Horsepower	CONSTANT
Torque	HIGH
Finish	ULTRA-SMOOTH

An exclusive coaxial spindle design combined with a unique, beltless-type, mechanical variator drive unit (5 HP), enables the Micro-Turn Lathe to deliver constant horsepower throughout entire speed range, actually maintaining drive speed output within two-tenths of one percent. Built-in torque responsive mechanism positively prevents slippage even under starting or shock loads. Maximum torque is assured at low speeds for heavy cutting, with super-smooth operation at highest speeds for ultra-fine finish, all complemented by the Micro-Turn's rigid construction and supreme balance.

Features include:

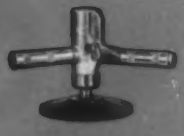
- pushbutton control with direct reading tachometer
- spindle speed ranges changed by pushbutton . . . without stopping spindle
- exclusive feed converter unit, located in apron, providing simple conversion from standard to optional feed ranges without affecting standard thread ranges
- double-wall, one-piece, totally enclosed apron
- fail-safe pressure lubrication to headstock, gear box and end gearing
- pressure lubrication to carriage and cross slide ways provided by pump located in apron; one-shot plunger to lubricate cross slide ways when carriage is stationary
- choice of manual or automatic coolant operation
- hardened and ground leadscrew, cross feed screw and compound rest screw

For the complete, illustrated story on the revolutionary MICRO-TURN, write today for your copy of Bulletin No. 222. Nebel Machine Tool Corporation, Lathe Division, 110 S. Cooper Ave., Cincinnati 15, Ohio.

NeBEL
MICRO-TURN*
HIGH SPEED PRECISION LATHE

*TM Reg. U.S. Pat. Off.

6" Vertical Grinder.



7" Vertical Sander.

6" Straight Grinder.

8" Straight Grinder.

NEW CP air-operated GRINDERS AND SANDERS

knock the high spots off grinding and finishing costs

High torque "Power Vane" motors deliver the power reserve that lets operators lay into tough hogging or snagging jobs. Speed sag is kept to a minimum so that every job gets done quickly and safely.

CP Grinders deserve their industry-wide reputation of cutting metal removal costs on every job. The compact, lightweight housings provide the handling ease for every metal finishing operation.

CP GRINDERS AND SANDERS GIVE YOU ALL THESE FEATURES:

- **30 MODELS TO CHOOSE FROM**
- **NEW LIGHTWEIGHT, HIGH TORQUE MODELS**
- **EFFECTIVE ACOUSTICAL SILENCING**
- **UNIVERSAL, HICYCLE, SUPER CYCLE ELECTRIC GRINDERS AND SANDERS**

The CP line includes: Straight and Vertical Grinders; Die Grinders; Small Wheel Grinders; Belt Grinders; Polishers and Sanders. For full details write:
Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.

Chicago Pneumatic

ELECTRIC TOOLS • PNEUMATIC TOOLS • AIR COMPRESSORS • DIESEL ENGINES
ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

For more data, circle this page number on Readers' Service Card

More Pieces COMPLETELY *finished in less time on*

GOSS & DeLEEUW AUTOMATIC CHUCKERS

This machine . . . already acknowledged and accepted as a metal-working achievement, and the only standard one of its kind . . . winds up a day's operation with all parts assigned to it completely finished and with no secondary operations necessary. When fully loaded, a complete piece is finished at each index cycle. High productivity is attained with simple tooling.

The "1-2-3" exclusive Goss & De Leeuw feature provides for finish machining three ends of a part simultaneously or in sequence. All operations are performed in a single set-up, and complete finishing done in much shorter time than by conventional methods.

●

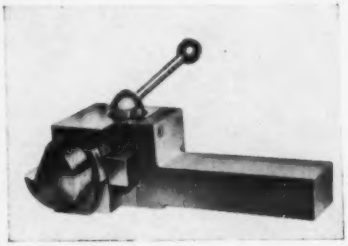
Send for illustrated literature which fully describes this recent Goss & De Leeuw development in chuckers. Submit samples of your work for time and cost estimates.

GOSS & DeLEEUW
QUALITY PRODUCT-QUANTITY

GOSS and DE LEEUW
MACHINE COMPANY, KENSINGTON, CONN., U.S.A.

Vers-O-Tool Thread Chaser

Single-chaser Vers-O-Tool announced by National Acme Co., Threading Tool Div., Cleveland,



Ohio, which backs off automatically at the end of the cutting stroke, thus boosting short-run threading efficiency. Designed to prohibit any return stroke while at cutting depth to eliminate scrapped parts due to damaged threads. Available in two sizes for fine or coarse threads, the Namco single-chaser Vers-O-Tool can be used on any lathe equipped with a lead-screw and will cut taper threads with any standard taper attachment.

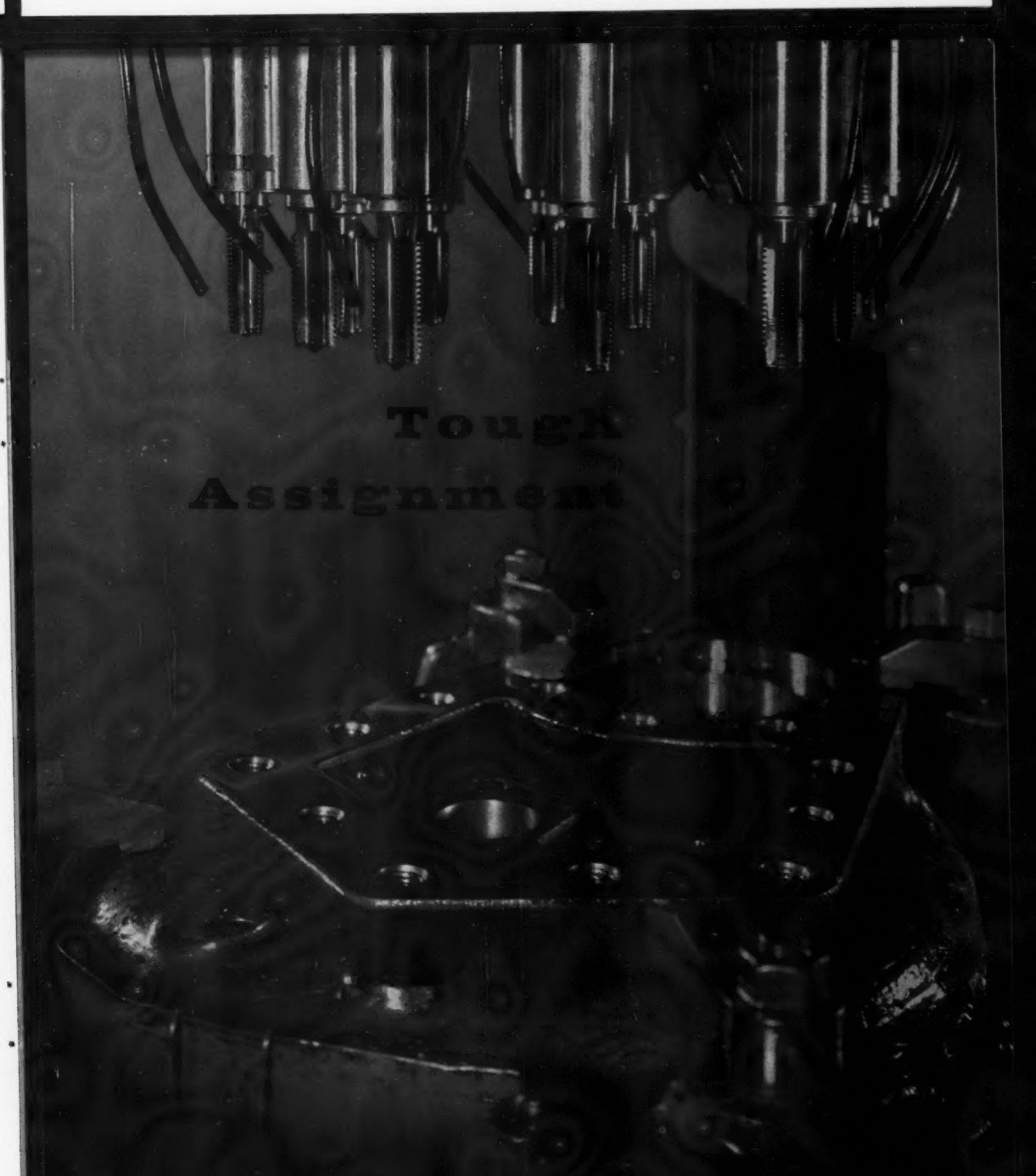
Circle 610 on Readers' Service Card

Arbor Type Press

Assembling and arbor press embodying the "Hydro Air" principle made by Pantex Mfg. Corporation, Pawtucket, R. I. The ram of

this versatile press can be lowered with light pressure to permit instant clamping of work for alignment or preadjustment prior to the application of high pressure under sensitive finger-tip control. The adjustable high pressure exerted by the ram is indicated on a dial.

Circle 611 on Readers' Service Card



Any tap man will tell you that tapping in armor plate is just as tough a job as one could ask for. Here 17 1 -8 GREENFIELD stock taps are simultaneously tapping Class 5 threads day after day in 2" armor plate Final Drive Cases for Military Tanks. Just another example of how the toughest jobs become routine with taps that can "take it". Buy taps with confidence, buy GREENFIELD taps.

GREENFIELD TAP & DIE GREENFIELD, MASSACHUSETTS

BEANS FULL OF KNOWLEDGE...

BINS FULL OF STOCK!

If you use alloy steels in your operations, you will find Wheelock, Lovejoy a most useful ally. W-L offers you complete servicing of your alloy steel needs. There are seven strategically-located W-L warehouses, each of which is fully staffed by veteran metallurgists, ready to give you expert advice as to grades, applications, heat treating, etc.

Each W-L warehouse maintains complete stocks of alloy steels, including standard AISI and SAE steels, and our own HY-TEN steels, which offer advanced metallurgical features at competitive prices.

With Wheelock, Lovejoy, you merely order the steel you need—as you need it—in specified sizes, shapes, grades and treatments.

For service that's complete, and completely satisfactory, call the W-L branch nearest you.

W-L STEEL SERVICE CENTERS – Cambridge • Cleveland Chicago • Hillside, N. J. • Detroit • Buffalo • Cincinnati

AGENTS – Southern Engineering Company, Charlotte, N. C.; Sanderson-Newbould, Ltd., Montreal & Toronto

"The Alloy Steel Center"

WHEELOCK, LOVEJOY & COMPANY, INC.

138 Sidney St., Cambridge 39, Mass.

STEEL SERVICE CENTER INSTITUTE

Buckeye Nutrunners and Screwdrivers with Torque Control

Buckeye Tools Corporation, Dayton, Ohio, reports that their 41F series of air-powered, pistol-grip screwdrivers and nutrunners has

been enlarged by the addition of two models equipped with a torque control clutch. This clutch is adjustable for any desired torque from 5 to 100 inch-pounds. Clutch jaws automatically disengage when a preset torque is reached and automatically reset for the next fastener.

Circle 612 on Readers' Service Card

Cam-Blanks of Laminated Plastic for Automatic Screw Machine

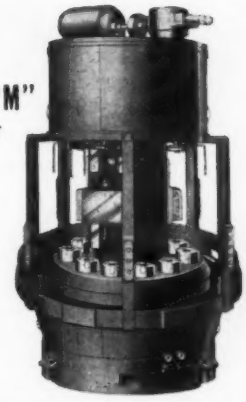
Cam-blanks of Synthane laminated plastic designed specifically for Brown & Sharpe automatic screw machines and available in all sizes either as individual cams or in sets from the Synthane Cor-

poration, Oaks, Pa. These cam-blanks are made from Synthane Grade C natural sheet. They are adapted for light work and/or short runs, and were developed to save setup time. Laminated-plastic cam-blanks have been found practical and economical for many B&S screw machines. They cost less than steel blanks and can be made in three easy steps: layout, band or jig saw to shape, and file to finish contour.

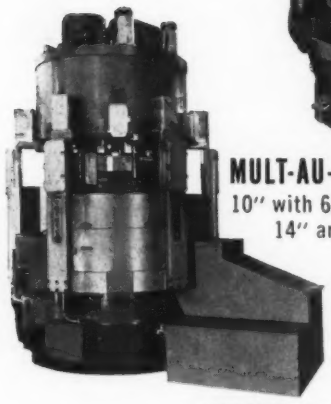
Circle 613 on Readers' Service Card

YOU CAN'T ....BEAT A... BULLARD..

to cut costs when cutting metal!



MULT-AU-MATIC, Type "M"
Available with 6, 8, or 12 spindles.



MULT-AU-MATIC, Type "L"
10" with 6, 8, 12, or 16 spindles, 14" and 18" with 6 or 8 spindles.

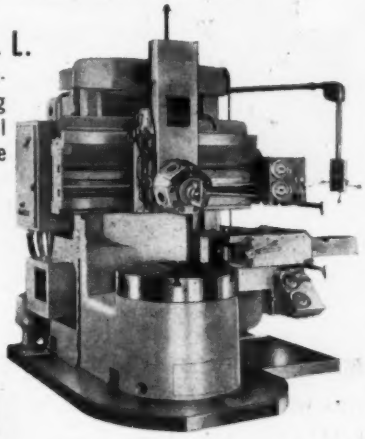
Before you buy, investigate the many outstanding features and advantages offered by modern Bullard Machine Tools.

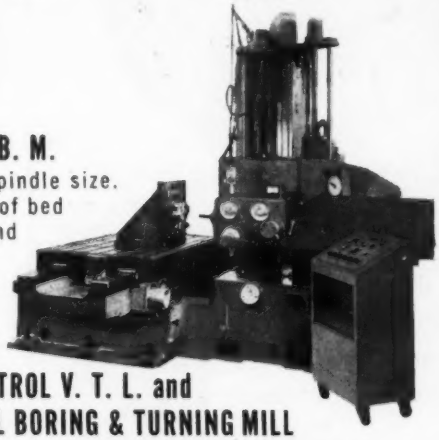
Day-in and day-out—they are proving their ability to produce more in less time—thereby reducing the cost per piece.

For the complete cost-saving story, call your Bullard Sales Office or write

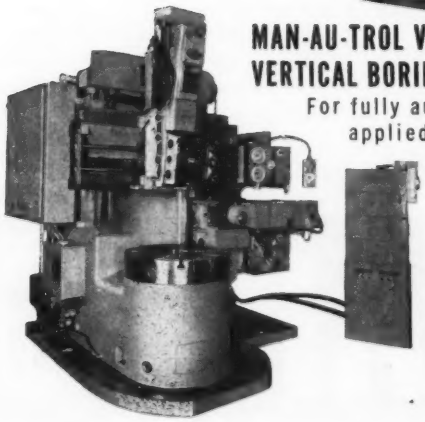
THE BULLARD COMPANY
BRIDGEPORT 9, CONNECTICUT

DYNATROL V. T. L.
26" to 86" in 10" increments. Discrete positioning or contouring numerical control system can be applied.



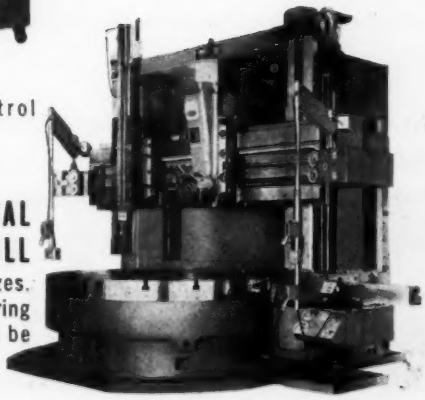


DYNAMILL H. B. M.
In 3", 4", and 5" spindle size. Many combinations of bed length, table size and vertical travel.



MAN-AU-TROL V. T. L. and VERTICAL BORING & TURNING MILL
For fully automatic operation, can be applied to any or all heads of Dynatrol at time of ordering or at later date.

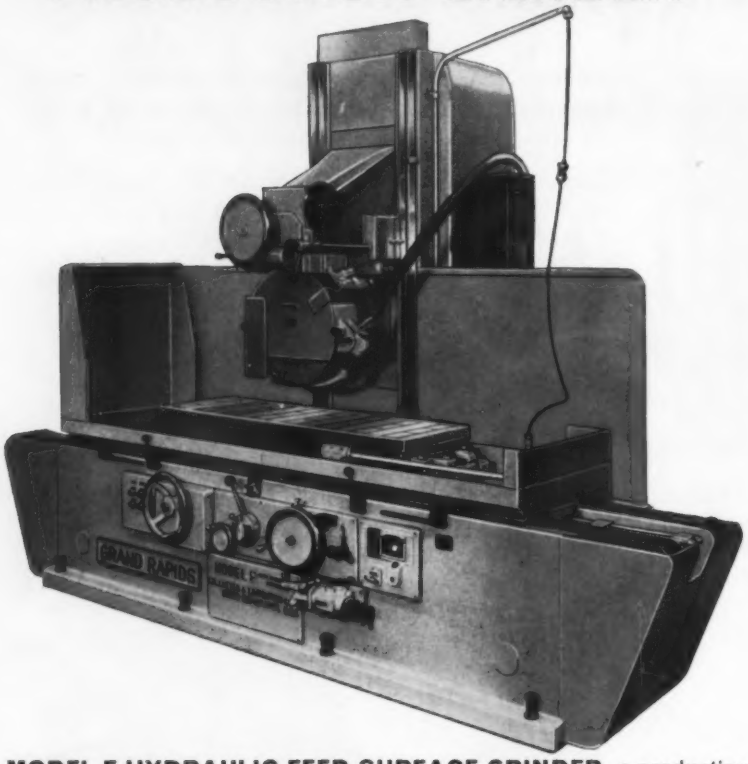
DYNATROL VERTICAL BORING & TURNING MILL
108", 124", and 144" table sizes. Discrete positioning or contouring numerical control system can be applied.



For more data, circle this page number on Readers' Service Card

PRODUCTION PRECISION

GRAND RAPIDS MODEL F PRODUCTION GRINDER



MODEL F HYDRAULIC FEED SURFACE GRINDER, a production type with cross sliding head, built in sizes ranging from 12″ x 18″ x 48″ to 30″ x 25″ x 120″. A heavy, powerful grinder with maximum table speeds of 150′ per minute. Motor mounted directly on grinding wheel spindle to assure that full power is transmitted directly to wheel. The machine illustrated is equipped with automatic downfeed which can be set to remove stock in increments from .0001 to .001 per table reversal.

New literature gives all the facts. Write for your copy.

GALLMEYER & LIVINGSTON CO., 305 Straight Ave., S. W., Grand Rapids, Mich.

Torque-Testing and Setting Gage for Power Tools

Precision torque-setting gage for testing nutrunners and screwdrivers under power to assure uniformity of tightness in assembly.

This portable tester, manufactured by Scully-Jones & Co., Chicago, Ill., measures torque-release limits with a repeatability of plus or minus 3 per cent. It provides a convenient, quick, on-the-job method of rechecking hand or power tools utilizing torque-limiting clutches. Designed especially to meet the needs of accurate assembly in instrument, missile, and aircraft plants. Available in two torque ranges—0 to 30 and 0 to 60 inch-pounds.

Circle 614 on Readers' Service Card

Wells Metal-Cutting Band Saw

Metal-cutting band saw of horizontal type in Models W-9 and F-14 made by W. F. Wells & Sons, Inc., Three River, Mich. This machine is equipped with automatic valve which eliminates many adjustments previously necessary, and also reduces maintenance

GRAND RAPIDS

costs. Both machines feature full hydraulic operation wtih easily set automatic cycle.

Circle 615 on Readers' Service Card

Air-Powered Wire Clippers

Pneumatically powered wire clippers specifically designed for production wire trimming announced by Chicago Pneumatic Tool Co., New York City. Requiring twenty-eight times less pressure to operate than conventional hand pliers,

these 6-ounce, featherweight "Air-Nips" eliminate the operator fatigue normally associated with manual wire clipping. They will cut soldered portions of 14-gage copper wire cleanly and instantly. The pointed cutting head can be rotated 180 degrees to get at hard-to-reach leads on printed circuit boards.

Circle 616 on Readers' Service Card

TOOLROOM PRECISION

GRAND RAPIDS MODEL 1230 O.D. & I.D. GRINDER

NO. 1230 HYDRAULIC FEED O.D. AND I.D. GRINDER meets the needs of users requiring a machine that does both internal and cylindrical grinding. It is a rugged, precision tool capable of taking rough cuts as well as producing the finest finish. Longitudinal table movement is controlled by valve or by hand wheel. Cross feed is actuated by hand wheel. Magnetic starters are furnished for each motor.

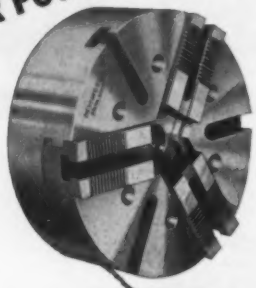
Write for copy of latest literature with complete details.

GALLMEYER & LIVINGSTON CO., 305 Straight Ave., S. W., Grand Rapids, Mich.

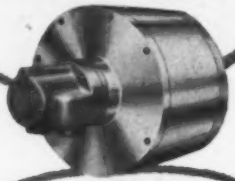
GRINDERS

GALLMEYER & LIVINGSTON

SP
SUPER POWER CHUCKS



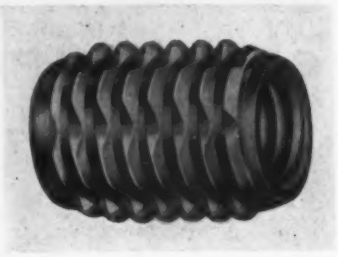
and
ROTATING
Air or Hydraulic
CYLINDERS



GIVE
YOU MORE
LONGER LIFE
FASTER SPEEDS
HEAVIER FEEDS
GUARANTEED
ACCURACY
For
S-P's INSIDE STORY
Get Catalog #112
Find us fast in the 'Yellow Pages'
Call or Write
A-6455A
The S-P Manufacturing Corp.
A BASSETT COMPANY
ESTABLISHED 1916
30201 Aurora Road • Cleveland 39, Ohio
Circle page number on Readers' Service Card

"No-Chip" Self-Tapping Threaded Inserts

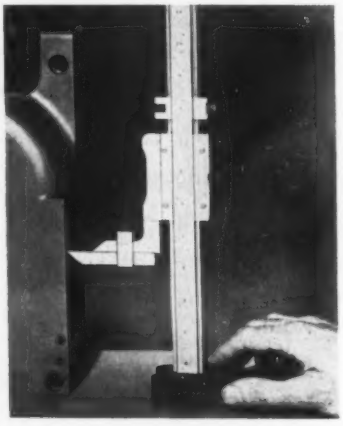
Self-tapping insert for low-cost, speedy installation of strong threads in plastics, aluminum, and magnesium alloys and other relatively soft materials announced by SpeedSerts, Inc., Los Angeles, Calif. The threads roll their way with a zero tolerance fit through the base material without cutting and prevent the inserts from backing out.



Circle 617 on Readers' Service Card

Starrett Lightweight Vernier Height Gage

Master vernier height gage combining correct balance and weight for easy handling where a lightweight gage is preferred. Developed by the L. S. Starrett Co., Athol, Mass. Available in 12- and 18-inch sizes featuring a long, fifty-division vernier with widely spaced, easy-to-read graduations. The vernier scale is flush-fitted in the same plane as the main scale to insure exact alignment of matching lines on bar and vernier, with no parallax problems to cause reading errors.



Circle 618 on Readers' Service Card

Macklin Grinding Wheels

Aluminum-oxide grinding wheels introduced by Macklin Co., Jackson, Mich. Known as the "27," this new line of abrasive wheels was developed to provide rapid stock removal. They can be used for heavy feeds on a variety of materials from high-speed steel and regular alloy steels to low-carbon steel and boiler plate. The manufacturer states that the "27" wheel grinds exceptionally cool, gives fast cutting action, and holds its form well. Extensive tests with these wheels showed excellent results in grinding aircraft parts, in crush-form applications, and surface grinding operations.

Circle 619 on Readers' Service Card

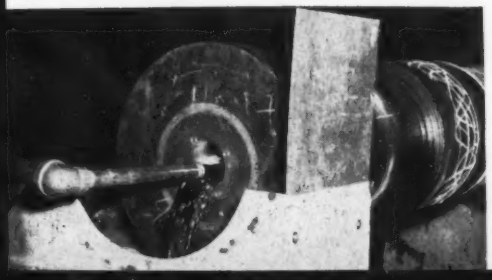
SPV Measuring Tool

SPV Unimeter for comparative measurement announced by Homestrand Machine Tool Corporation, Greenwich, Conn. The measuring jaw operates without play and friction and is spring-

At Homestead District Works, U. S. Steel–

MICROHONING CUTS BORE FINISHING TIME FROM 60 HOURS TO 4 HOURS

Getting it from both ends, the shaft bore receives a copious supply of coolant. A large capacity coolant filter unit, and a special trough system, keep the coolant circulating to provide a means of flushing the swarf from the work area, and contributing to a more effective cutting action of the abrasives.



The bore of a typical large steel shaft forging is now finished in four hours by Microhoning . . . an operation which previously took *sixty* hours of dry lapping! The forgings—for ship shafts, turbines, and cyclotron electrodes—range from 2′ to 5′ in diameter and as long as 45′ (114 tons).

Designed to operate at high speeds, it is essential that the bores be accurate, straight, concentric with the O.D. and with a specified microfinish. After the bore is finished, the ends are plugged with centers to machine the O.D.

In typical performance Microhoning removes approximately .025″ stock from a 4.5″ bore 27′ long in one hour and with a surface finish of 10-20 rms. Bores previously were lapped for 60 hours and more.

Micromatic Hone provides all the machining elements . . . machine, tooling, abrasives, coolant. This integrated approach is a significant factor in the achievement of these spectacular savings for U. S. Steel. You, too, can benefit from the one-source approach to honing operations . . . a call or letter will bring a field engineer to point up the specifics for your application. Why not do it today.

MICROMATIC HONE
CORPORATION
SCHOOLCRAFT AT GREENLAWN • DETROIT 38, MICHIGAN

Electronic Talyvel

checks level to distance of 300 feet

"New Generation" Leveling

The Talyvel is a precise, completely portable level, battery operated. An electronic displacement signal, transistor-amplified, is fed to a zero-center meter. The meter is scaled in both angular and linear measures to indicate exact tilt of level. The pointer comes to rest in about 1 second of time; repeatability is approximately 1 second of arc.

The Talyvel is designed for use in the many places where reading a block level is difficult. The instrument is particularly valuable for checking machine tools and launchers for missiles and rockets; for releveling and adjustment control.

For complete information, ask for Catalog TY-111

ENGIS EQUIPMENT COMPANY
431 S. DEARBORN ST.
CHICAGO 5, ILL. U.S.A.

Division of Engineering and Scientific Instrumentation

Circle page number on Readers' Service Card

actuated to give constant measuring action. After the reference dimension has been set up with gage-blocks or otherwise, unskilled personnel can measure accurately and quickly, the accuracy of the indicator being the limiting factor. Anvils are available for outside- and inside-diameter, O-groove, V-groove, and thread measuring. Ranges from 1 1/2 to 14 inches are available as standard.

Circle 620 on Readers' Service Card

Unique Work-Clamping Screw

Torque thumbscrew swivel-pad clamp, recently added to the line of tooling accessories offered by Vlier Engineering Corporation,

Los Angeles, Calif. This device is a combination of the Vlier torque thumbscrew, a holding tool which applies a controlled end pressure, and the Vlier swivel-pad clamp, which permits a part to be securely held without marring its surface. Available in four sizes ranging from 1/4-20 by 2 1/2 inches long to 1/2-13 by 3 inches long.

Circle 621 on Readers' Service Card

Cleco Impact Wrench

Impact wrench for 1 1/4-inch bolts, designed to deliver more power with less weight than preceding models, developed by Cleco Air Tools, Houston, Tex., a division of Reed Roller Bit Co. This unit, styled the W-1000 impact wrench, features an exclusive "single-pak" power unit which houses fewer moving parts and weighs 41 per cent less than previous models. Lighter and shorter than preceding units, this tool has its impact mechanism incorporated as part of the air motor. This provides a fast run-down and impacts to a high torque. The unit's slim nose design permits work in previously inaccessible areas. The throttling action is smooth and the tool does not impact on the free run-down. The detachable handle is adjustable through 360 degrees. The entire assembly is line-bored to facilitate disassembly and reassembly.

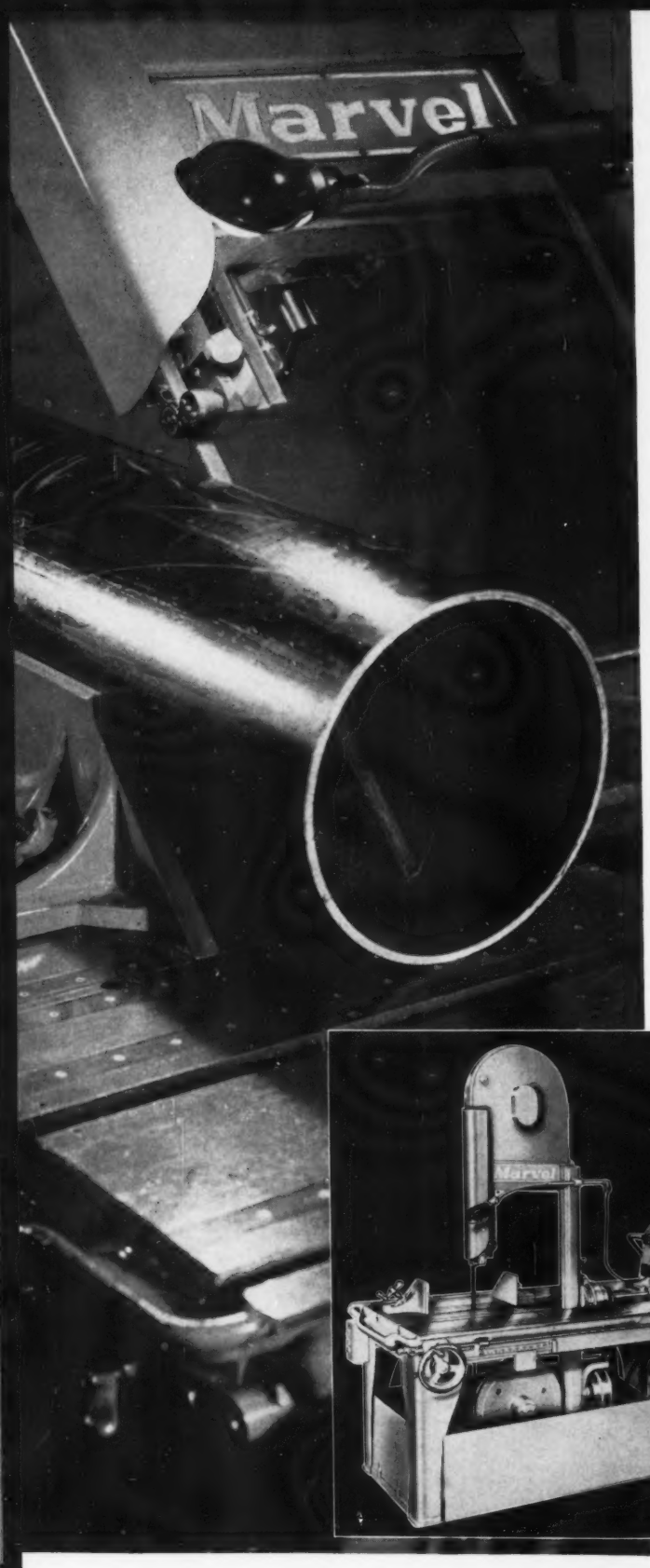
Circle 622 on Readers' Service Card

Starrett Satin-Chrome Steel Tape

One of a new line of steel tapes introduced by the L. S. Starrett, Co., Athol, Mass. Tape is 3/8 inch wide, high-quality tempered steel with a hard-wearing, corrosion-resistant, multiple-plate satin-

chrome finish. Graduations and figures are recessed. Graduations are in feet, inches, and eighths of an inch. Red figures show number of feet before every inch mark. Cases are electroplated steel sections covered with wear- and weather-resisting red vinyl secured by a heavy concave-convex nickel-plated ring. Nylon rollers protect the tape line and case at the opening. Available in 25-, 33-, 50-, 66-, 75-, and 100-foot sizes. Also available in metric and English metric graduation models.

Circle 623 on Readers' Service Card



Problem:

One Straight Cut... *One Miter Cut*

Solution:

One MARVEL No. 8 Band Saw

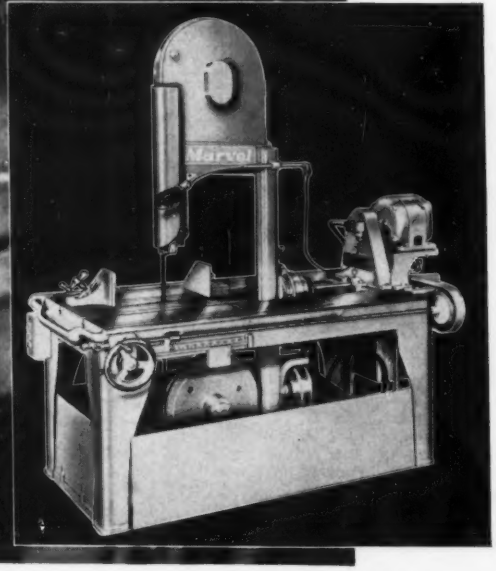
Recently, a MARVEL Field Engineer was called on to help solve a troublesome production sawing operation.

He found that a straight cut and a 45° miter cut were required on a 10″ diameter pipe prior to welding it into an assembly. Production was slow, cutting costs were climbing to alarming proportions, and too many pieces were being rejected because one or both cuts were not meeting accuracy standards.

The trouble was easy to find. A makeshift arrangement was being used to do the job. After the straight cut was made, the miter was laid out and the pipe swung out into the aisle so that the saw could make the angle cut. Excessive work handling slowed production, valuable floor space was taken up, and accuracy became increasingly difficult to maintain.

Recommending a MARVEL No. 8 Universal Band Saw solved the problem. When the MARVEL Field Engineer showed how the Saw's column and blade can be tilted up to 45° right or left of vertical and fed straight into and through the cut at the pre-determined angle *while the work remained stationary on the table*, the production superintendent recognized the answer to his problem. He also saw, how the built-in protractor would eliminate all layout.

Result: another MARVEL No. 8 Universal Band Saw went to work for a new user.



Cutting miters quickly and accurately is just one of a hundred jobs that can be done on the versatile No. 8 Universal Band Saw ... the most useful—and used—metal cutting saw on the market. Get complete information on this time and cost saving band saw today. Write for Catalog 875.

Marvel No. 8 Universal Metal Cutting Band Saw
Capacity: 18″ x 18″

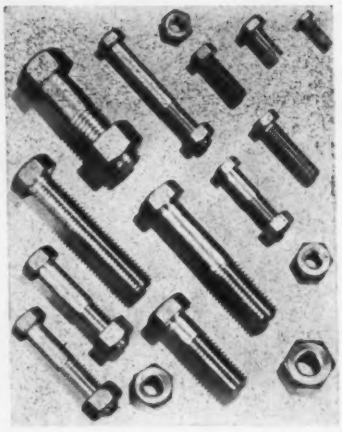
MARVEL *Metal Cutting* **SAWS**

BETTER MACHINES
BETTER BLADES

ARMSTRONG-BLUM MANUFACTURING CO. • 5700 Bloomingdale Avenue • Chicago 39, Illinois

Bolts, Nuts, and Special Fasteners of Various Materials Available

Bolts, nuts, and fasteners of aluminum, silicon bronze, and stainless steel brought out to complement the broad line of steel and nonmetallic fasteners made by Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y. Specially designed and traditional fasteners from these new materials are being developed to meet requirements for high corrosion resistance, high strength-to-weight ratio, and light weight needed in many modern applications. Aluminum hex screws from 2024-T4 alloy and hex nuts from 6061-T6 alloy are carried in stock from 1/4- through 3/4-inch diameter. No. 10 and 1/4-inch open-end acorn locknuts are also available from stock. Extensive stocks of silicon-bronze hex nuts, heavy nuts, and hex screws through 3/4-inch diameter are now maintained. Stainless-



steel hex screws and nuts are manufactured from Type 305 alloy up to 3/4-inch diameter in lengths to 9 inches.

Circle 624 on Readers' Service Card

PRODUCTION-MINDED and PRECISE

When the name plate states "It's a HAMILTON TOOL," you can "Use it with confidence."

The NEW Hamilton-Varimatic,® a radial type drilling machine with super sensitive feed, produces small holes (to 5/16" dia.) with instrument precision — at production speeds.

Spindle speeds are infinitely variable. A simple adjustment of the graduated hand wheel selects any desired spindle speed between 840 and 2700 R.P.M., or between 2900 and 9300 R.P.M.

It is available with conventional base and work table, or with "toolroom base" and compound table as shown at the left. Also offered in multiple spindle designs.

2959

HAMILTON TOOL

GET THIS

Bulletin No. 2959 provides complete description, includes sectional drawing, lists features, gives specifications. It's FREE. Write for it now!

THE HAMILTON TOOL COMPANY

834 SOUTH NINTH STREET HAMILTON, OHIO

Miniature Solid-Carbide Boring Tools

Miniature, precision-ground solid-carbide boring tools announced by the Atrax Co., Newington, Conn. These tools have been designed specifically for the precision jig boring of small, close-tolerance holes and are available in seven miniature sizes to permit

boring holes from 0.020 to 0.080 inch in diameter. Top rake and relief angles are highly lapped to mirrorlike finishes. These tools have been found especially well-adapted for the machining of components for aircraft instruments, gyro gimbals, and other miniature equipment.

Circle 625 on Readers' Service Card

EDLUND MODEL NPB

PRINTED CIRCUIT BOARD DRILLING MACHINE

DRILL PRINTED CIRCUIT BOARDS FASTER, CHEAPER, AND MORE ACCURATELY

Now High Speed, Versatile, Tape Controlled Machine drills Printed Circuit Boards with amazing accuracy in a wide variety of material at low cost.

This High Production drilling machine is actually 16 drills in 1, it drills four boards or stacks of boards simultaneously, operating at 50 cycles per minute under average conditions. **Time Saving Versatility** is featured with 4 independent air feed units in each drilling cluster, each unit capable of carrying a different drill size and operating at spindle speeds up to 22,000 RPM. **The Tape Controlled point positioning** table and drill units assure maximum accuracy and reliability. Now drilling speed and size changes are done automatically, eliminating time consuming manual tooling and set-up.

Printed Circuit Boards Drilled on Edlund Machine

Edlund Model TPR Programmer for Tape

EDLUND PROGRAMMER PREPARES TAPE DIRECTLY FROM ART WORK

This unique Programmer prepares 1" 8-channel tape **DIRECTLY** from the draftsmen's art work at a **LOW INITIAL** and **LOW UPKEEP** cost.

ELIMINATE MASTER BOARDS and **SAVE** by preparing tape directly from art work. **HIGH SPEED PERFORMANCE** locates up to 30 positions per minute. **MAXIMUM ACCURACY AND RELIABILITY** are the result of the unique design which corrects errors in the art work and keeps the programming process on the desired grid automatically. **INDEPENDENT OPERATION** permits tapes to be prepared when drilling machine is in use. **COMPLETE VERSATILITY** is provided by precision interchangeable slides allowing the Programmer to handle grid sizes down to .025" including unusual grids.

Write for FREE Descriptive Bulletins

EDLUND MACHINERY COMPANY

Division of Harsco Corporation Cortland, New York

Edlund Representatives in Major Cities

Cuts any shape... at speeds up to 120 fpm!

BEATTY QUICKWORK ROTARY SHEARS

The fast, accurate way to
CUT STRAIGHT LINES
CUT REVERSE CURVES
CUT OPENINGS
CUT ODD SHAPES
CUT NARROW STRIPS
CUT BEVELS
CUT CIRCLES
FORM FLANGES
JOGGLE

Combining lightning speed with rigid precision, the Beatty Quickwork Rotary Shears offers new economies to the metal fabricator. Here is a single versatile machine which does the work of seven; its unique cutter assemblage facilitates shearing in irregular shapes and straight lines. Available in a complete range of sizes for cutting plate and sheet metal up to 1" mild steel.

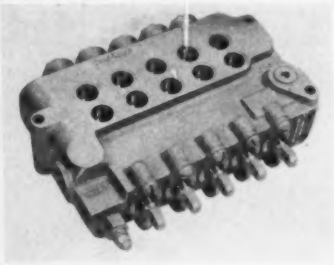
SEND TODAY for your copy of Beatty Bulletin No. BQ-100 containing full information on Quickwork Rotary Shears, and Bulletin No. BQ-120, illustrating auxiliary attachments for joggling, flanging, slitting, and circle cutting.

QUICKWORK

Division; BEATTY MACHINE & MFG. Co., 941 150th St., HAMMOND, Ind.

Five-Spool Control Valve

Newly developed addition to the line of hydraulic directional control valves for mobile equipment made by Parker-Hannifin Corporation, Cleveland, Ohio. This five-spool model has a nominal rating of 12 gpm. Spools are of optional types: double-acting or "push" or "pull" for single action are available. Each spool has an individual load check, and the valve has an integral pilot-operated relief. Maximum recommended operating pressure is 2000 psi.



Circle 626 on Readers' Service Card

NEW PRODUCT BRIEFS . . . . .

PULSED X-RAY SYSTEM that charts motion and performance of totally enclosed, hidden moving parts undergoing vibration and shock tests announced by MB Electronics, a division of Textron Electronics, Inc., New Haven, Conn. This X-ray system will show a sharp image despite vibration. Information on hidden-part movements during environmental tests with this equipment can be used as the basis for design changes to improve product performance. The pulsed X-ray system is a development of the Zenith Radio Research Corporation.

Circle 627 on Readers' Service Card

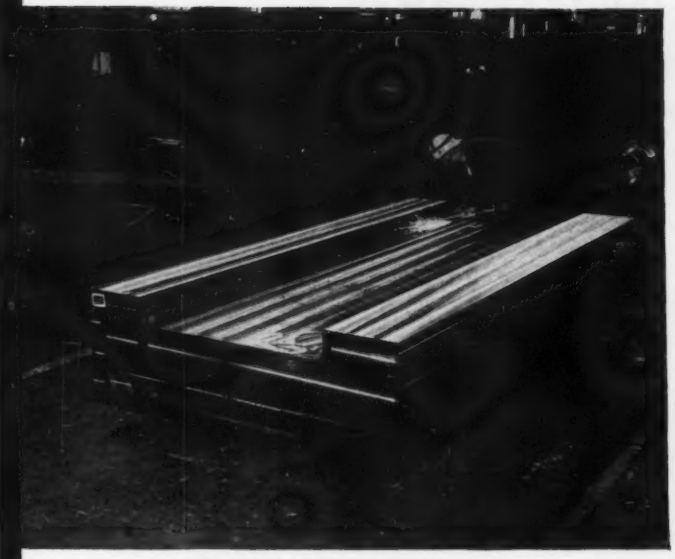
SWEAT FURNACE designed to recover nonferrous metals that are bonded to other metals manufactured by Warwick Industrial Furnace & Engineering Corporation, Franklin Park, Ill. Used or scrapped parts made of bimetallic components are fed into the first furnace, causing the metal that melts at the lower temperature to flow off into the second furnace where it can be readily processed and refined, then poured into pigs. The remaining metal

(Continued on page 233)

You name it...we'll forge it!

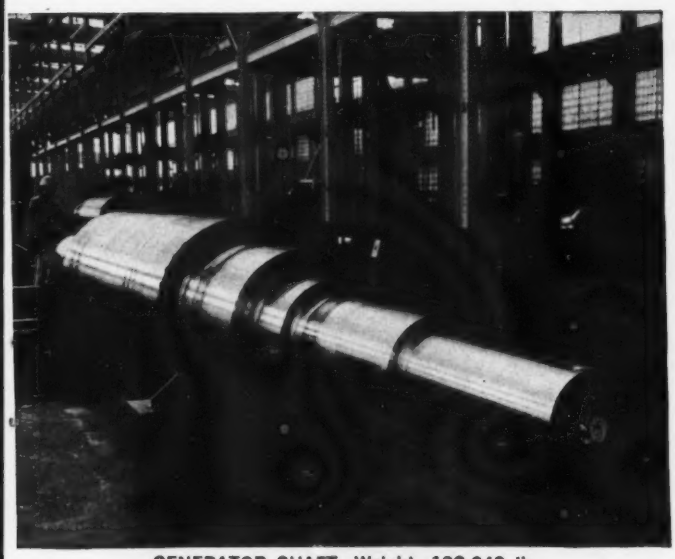
RIGHT ON THE NOSE. Bethlehem meets your specifications exactly on all types of press, drop, and hammer forgings.

for Strength
... Economy
... Versatility



RAM ADAPTER. This forging weighs 58,780 lb, and measures 140 in. x 73 in. x 25 in.

STEEL CYLINDER for use in 7,500-ton plate stretcher. This forging weighs 171,240 lb, and it's 17 ft, 3 in. long.



GENERATOR SHAFT. Weight, 198,240 lb. As you can tell from these photos, Bethlehem is well-equipped for machining.

REACTOR VESSEL CLOSURE. The OD of this 50,660-lb forging measures 12 ft.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

NEWS of the Industry

Isabel Shamlian

California and Washington

W. F. & JOHN BARNES CO., Rockford, Ill., has announced the appointment of two Pacific Coast distributors. Exclusive representation in southern California and Arizona will be provided by HOFFMAN & HEARTT, Los Angeles. The new distributor for northern California is BULOTTI MACHINERY CO., San Francisco.

JOSEPH E. FURTNER has been made sales engineer of numerical positioning controls for the Electronics Division of RHEEM MFG. CO., New York City. The division headquarters are in Los Angeles, Calif.

DAVIS G. TAYLOR has been made a sales engineer with the West Coast district by PANGBORN CORPORATION, Hagerstown, Md. Mr. Taylor will operate out of Alamo, Calif.

As an expansion of sales outlets, SEATTLE HARDWARE CO., Seattle, Wash., has been named an authorized distributor of Carboloy cutting tools by METALLURGICAL PRODUCTS DEPARTMENT of GENERAL ELECTRIC CO., Detroit, Mich. The firm will serve the state of Washington and the northern Idaho area.

Illinois and Missouri

COLUMBIA TOOL STEEL CO., Chicago Heights, Ill., has announced the retirement of ARTHUR T. CLARAGE as chairman and president of the firm. He has completed forty-seven years of active service with the company and thirty-six years as chief executive officer. ADOLPH JOSEPH SCHEID, assistant to the president, has been elected president to fill the vacancy. Also announced is the retirement of ADOLPH J. SCHEID, JR., vice-president, manufacturing technology and quality control.

SCULLY-JONES & CO., Chicago, Ill., has appointed two new distributors in Michigan and Indiana for its complete line of precision holding tools. ASHTON TOOL SUPPLY CO., Detroit, now represents Scully-Jones in the Michigan counties of Wayne, Monroe, Livingston, Washtenaw, St Clair, Oakland, and Macomb. CROWN EQUIPMENT CO., INC., Indianapolis, is the new distributor in all Indiana counties south of and including Warren, Tippecanoe, Carroll, Howard, Madison, Delaware, and Randolph.

JOSEPH T. RYERSON & SON, INC., Chicago, Ill., has appointed ROBERT H. WASZ assistant vice-president. He will have the responsibility of administering the company's fabricating and manufacturing activities. Succeeding Mr. Wasz as general manager of the San Francisco, Calif., plant is NORMAN F. REWOLDT, who was formerly manager of work order sales.

FRANK L. BRUGGER, product sales manager for KENNAMETAL INC., Latrobe, Pa., for the past four years, has become field sales supervisor in the southwest. In addition to responsibility for sales of metalworking tools, Mr. Brugger will be in charge of sales development of special products in a number of other industries. He has established headquarters in St. Louis, Mo.

Michigan

DONALD W. HANSON has joined the Diamond Marketing Subsection, METALLURGICAL PRODUCTS DEPARTMENT, GENERAL ELECTRIC CO., Detroit, Mich. He will serve as specialist—marketing research and product planning.

DAVID LOWMAN has been appointed sales engineer by CAPEWELL MFG. CO., Hartford, Conn., for its complete line of metal-cutting saw blades, hammers, and tool steel in the state of Michigan.

RICHARD D. CHAPMAN has been named chief of the COPPER & BRASS RESEARCH ASSOCIATION'S newly created office in Detroit, Mich. Mr.

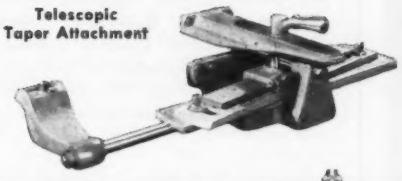
Richard D. Chapman, chief of the Detroit office of Copper & Brass Research Association

Chapman was formerly assistant chief engineer, basic science research, of CHRYSLER CORPORATION. He will temporarily make his headquarters at 19730 Ralston St., Detroit 3, Mich., and in the near future he will be moving to more spacious quarters.

SAGINAW BEARING CO., Detroit, Mich., has elected M. C. PATTER-

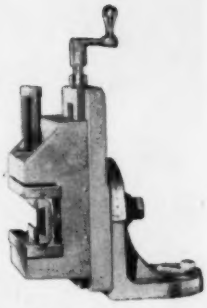
M. C. Patterson, president and treasurer of Saginaw Bearing Co.

Telescopic Taper Attachment

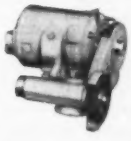


Ball Bearing Live Centers

Follower Rest

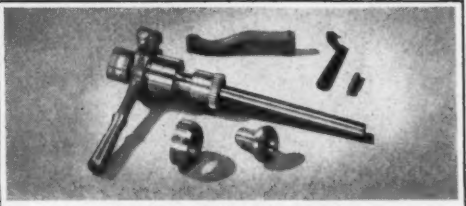


Milling Attachment



External Grinder

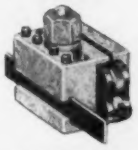
Steady Rest



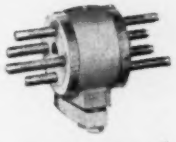
Handlever Collet Attachment

Handwheel Collet Attachment

Collets



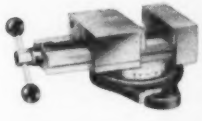
10-IN-1 Tool Holder



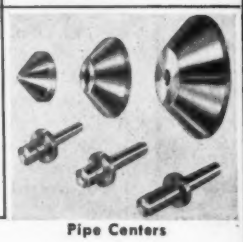
4-Position Carriage Stop

Square Turret Tool Block

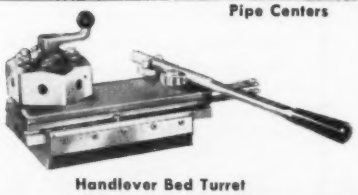
Cutter Bit Grinding Block



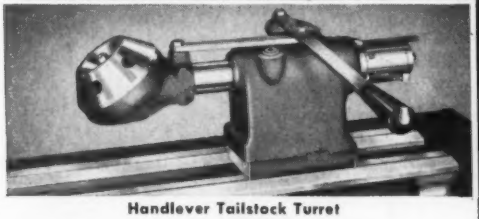
Swivel Machine Vise



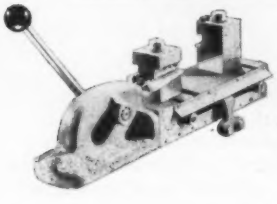
Pipe Centers



Handlever Bed Turret



Handlever Tailstock Turret



Handlever Double Tool Cross Slide

SOUTH BEND

ATTACHMENTS

help you get more work out of your machines

- CUT MACHINING TIME
- SIMPLIFY DIFFICULT JOBS
- SPEED UP TOOLING
- HANDLE MORE TYPES OF JOBS

SOUTH BEND LATHE, INC., South Bend 22, Ind.
Builders of Lathes, Milling Machines, Shapers, Drill Presses and Pedestal Grinders

SOUTH BEND

SOUTH BEND LATHE, INC., South Bend 22, Ind.
We would like to know more about all 212 South Bend Machine Tool Attachments.

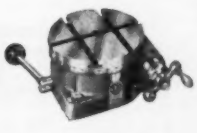
Name_____ Title_____

Company_____

Street_____

City_____ Zone____ State_____

Universal Table



Rotary Indexing Table

Indexing Centers

AUTOMATIC BRUSHING SETUP buffs mirror finish on 12" wrench parts for plating. Multiple parts are mounted in special removable fixture. Machine automatically positions and oscillates parts between brushing heads for 25 strokes per cycle. Each head is made up of 65 Osborn Bufcut® treated cord brushes.

MIRROR FINISHING wrenches

nine at a time with OSBORN power brushing

This leading tool manufacturer uses Osborn power brushing to buff a mirror finish on forged steel wrenches, pliers and chisels before plating.

Pre-mounted in multiples on removable fixtures, the tool parts are buffed in a special machine which automatically lowers and oscillates the parts between two Osborn Bufcut® brushing heads. The operation is simple, fast, inexpensive. This method has been in continuous use in this plant for nearly 12 years—*still proves to be the best way to do the job today.*

It's a typical example of how Osborn power brushes and brushing methods—through years of exceptional, dependable service—are handling industry's tough metal finishing jobs. If you have a metal finishing problem—deburring, cleaning, polishing, precision blending—an **O**sborn **B**rushing **A**nalysis, made in your plant at no obligation, can pinpoint the answer. *Write or call The Osborn Manufacturing Company, Dept. D-67, Cleveland 14, Ohio. Phone ENdicott 1-1900.*

OSBORN

Metal Finishing Machines . . . and Finishing Methods
Power, Paint and Maintenance Brushes • Foundry Production Machinery

SON president and treasurer of the company. Mr. Patterson, former DODGE DIVISION general manager and CHRYSLER CORPORATION vice-president, succeeds WILLIAM AGRICOLA, son of the firm's founder, who will retire February 1.

ROBERT F. MORGAN, a sales engineer with considerable experience in dust control, has joined the Detroit, Mich., sales staff of PANGBORN CORPORATION, Hagerstown, Md.

ROBERT L. DENEAU has been appointed sales engineer in the Detroit, Mich., office of W. F. & JOHN BARNES CO., Rockford, Ill. He will handle automotive accounts in the Michigan and New York areas.

NORMAN H. FOSTER has joined F. JOS. LAMB CO., Detroit, Mich., as a sales engineer. He will represent the firm in Detroit and part of Canada.

New England

THREADWELL TAP & DIE CO., Greenfield, Mass., has announced that construction has begun on the first units of a new cutting-tool center to be erected in Greenfield. The installation will be located at the eastern foot of the Mohawk Trail, and just off the new U. S. Highway 91 which will run from New York City to the Canadian border. The first unit will consist of a 65,000-square-foot office and plant which will house Threadwell's tap, die, keyway broach, and gage manufacturing operations. The firm's CONWAY MFG. DIVISION will also be incorporated in the facility. Plans call for expansion of the center to provide for the COGSDILL TWIST DRILL DIVISION in addition to other products.

WILLIAM N. RIDER has been appointed sales agent for the southwest territory of LAMINATED SHIM CO., INC., Glenbrook, Conn. His territory will include Louisiana, Texas, Oklahoma, and parts of Kansas.

New York

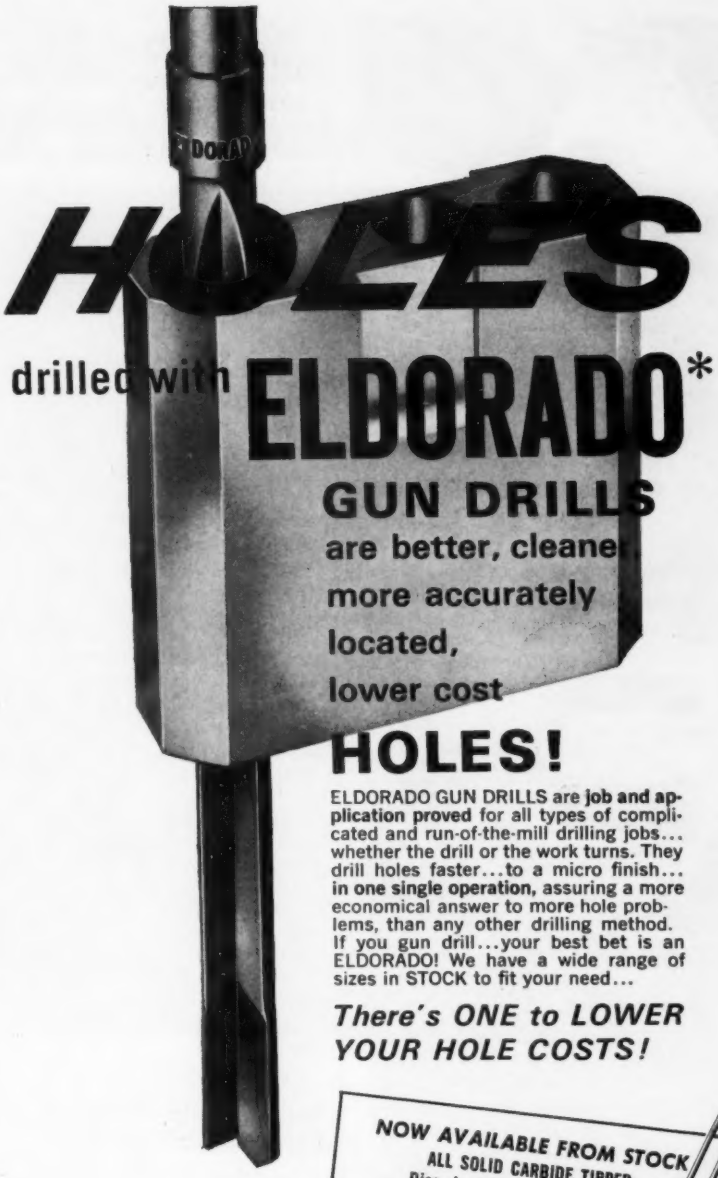
MARLIN-ROCKWELL CORPORATION, Jamestown, N. Y., has announced the opening of new branch sales offices in Charlotte, N. C., and Boston, Mass. The Charlotte office, located at 2826 N. Graham Ave., Charlotte 6, has 4000 square feet of floor area. A complete line of MRC ball and roller bearings will be carried in stock to service distributors

in the Carolinas, eastern Tennessee, and parts of Virginia and West Virginia. W. B. LAYMAN will take over the post of manager of the new branch. The Boston office is located at 149 Cambridge St., Boston 34. It will provide 4000 square feet of office and warehouse space. Its stock of MRC bearings will help the company provide even better service to its distributors in the New England area. The office will be in charge of J. H. LEBARON, resident sales engineer, assisted by R. W. GUSTAFSON.

AMERICAN DIE CASTING INSTITUTE INC., New York City, has elected WALTER E. BROWN—executive vice-president of KIOWA CORPORATION, Marshalltown, Iowa—president of the institute. Succeeding Mr. Brown as vice-president is W. G. NEWTON, JR., president of NEWTON-NEW HAVEN CO., West Haven, Conn. Also announced was

Walter E. Brown, president of American Die Casting Institute

Alfred F. Bauer, presented with Annual Doehler Award by American Die Casting Institute



ELDORADO GUN DRILLS are **job and application proved** for all types of complicated and run-of-the-mill drilling jobs... whether the drill or the work turns. They drill holes faster...to a micro finish... **in one single operation,** assuring a more economical answer to more hole problems, than any other drilling method. If you gun drill...your best bet is an ELDORADO! We have a wide range of sizes in STOCK to fit your need...

There's ONE to LOWER YOUR HOLE COSTS!

NOW AVAILABLE FROM STOCK
ALL SOLID CARBIDE TIPPED
Dias. in every 1/64" increment

Size-Dia.	LENGTH	Driver
.1250" to .5000"	10", 16", 22"—all dias. 28", 36"—most dias.	¾" x 2¾"
.5156" to .7500"	16", 22", 36"	1" x 2¾"
.7656" to 1.0000"	22", 36"	1¼" x 2¾"

IMMEDIATE SHIPMENT

Also custom made Gun Drills in all dias. up to 2" in any length within dia. limits —ON NORMAL DELIVERY

ELDORADO'S specialized Engineers and research facilities are available to assist you in the selection of the right gun drill tool or drilling method to solve special hole drilling problems.

ORDER OR WRITE TODAY

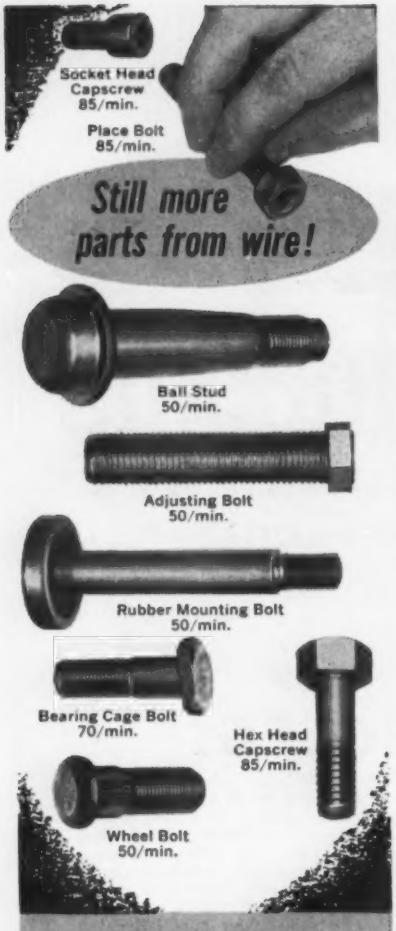
Specializing 100% in Gun Drills and Related Tools

ELDORADO TOOL & mfg. corp.

Trade Mark

348 BOSTON POST ROAD • MILFORD, CONN.

For more data, circle this page number on Readers' Service Card 223

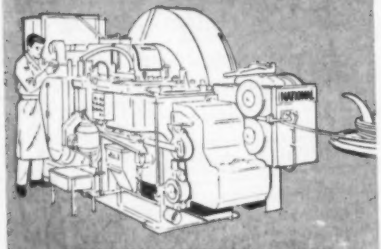


BOLTMAKERS make these interesting parts, and countless others, every day from wire.

Operations include cutting off, extruding, heading, trimming, pointing and thread-rolling.

It's just possible *your* metal parts can be made faster, stronger and at lower cost in Boltmakers (or in other types of Nationals).

May we help you investigate?



NATIONAL ½-INCH BOLTMAKER
4,200 PARTS PER HOUR!

NATIONAL MACHINERY CO.
TIFFIN, OHIO, U. S. A.
HARTFORD DETROIT CHICAGO

Circle page number on Readers' Service Card

the presentation of the Annual Doehler Award to ALFRED F. BAUER, manager, DOEHLER-JARVIS DIVISION, NATIONAL LEAD CO., in recognition of his outstanding contributions to the advancement of the die-casting art.

SANFORD B. KAYNOR has been elected secretary of U. S. INDUSTRIES, INC., New York City. Mr. Kaynor joined the company in 1958 as a member of the legal staff. He became assistant secretary in 1959.

Ohio

E. W. BLISS CO., Canton, Ohio, has named B. E. MEYER sales manager of the Hastings (Mich.) Division. In this position, Mr. Meyer will supervise all sales of the company's complete line of metalworking presses, in addition to the line of can-making machinery for which he is currently responsible. He succeeds STANLEY E. HUFFMAN, who is now representative for Bliss presses and other lines of industrial equipment in the Rochester, N. Y., area. In addition, PAUL JONES has been appointed general manager of the Hastings Division. ROBERT SHANNON, formerly division manager, will continue to serve in a consulting capacity.

ALEX J. SZABO has been named sales engineer, Cleveland, Ohio, district, by PANGBORN CORPORATION, Hagerstown, Md. For the past year he has been supervisor, Vibratory Finishing Division, in the Hagerstown plant.

Pennsylvania, Maryland, and District of Columbia

AIR REDUCTION SALES CO., a division of AIR REDUCTION CO., INC., New York City, has announced the following. ANDREW KAUL III, chairman and chief executive officer of SPEER CARBON CO., INC., was elected a director of Air Reduction. Mr. Kaul's offices will be at Speer's headquarters in St. Marys, Pa. C. J. LANGLEY has been appointed manager of Air Reduction's Philadelphia district. R. B. CALHOUN has been made assistant manager of distributor sales for the Pittsburgh district, with responsibility for the marketing of the firm's products through authorized Airco distributors in western Pennsylvania, southeastern Ohio, northern West Virginia, and western Maryland. S. N. PETERS has been appointed plant superintendent of the company's air separation plant presently under construction in Johnstown, Pa. In his new capacity, Mr. Peters will be responsible for the operation of Airco's 675-ton-per-day Johnstown facility, which will supply oxygen by pipeline to BETHLEHEM STEEL CO. blast furnaces at that location when it is completed later this year.

BALDWIN-LIMA-HAMILTON CORPORATION, Philadelphia, Pa., has purchased all patent, manufacturing, and marketing rights to two automatic tube-bending machines, both called Bend-O-Matic. One model, specifically designed for producing the variety of tail pipes required by different makes and models of cars and trucks, was designed by B-L-H's Industrial Equipment Division to a concept developed by NU-ERA CORPORATION, Rochester, Mich. The other model, a similar machine, was developed by WALTER P. HILL, INC., Detroit. This machine, now called the Series 200 to distinguish it from the Series 100 (tail pipe) machine, is designed for general industrial use.

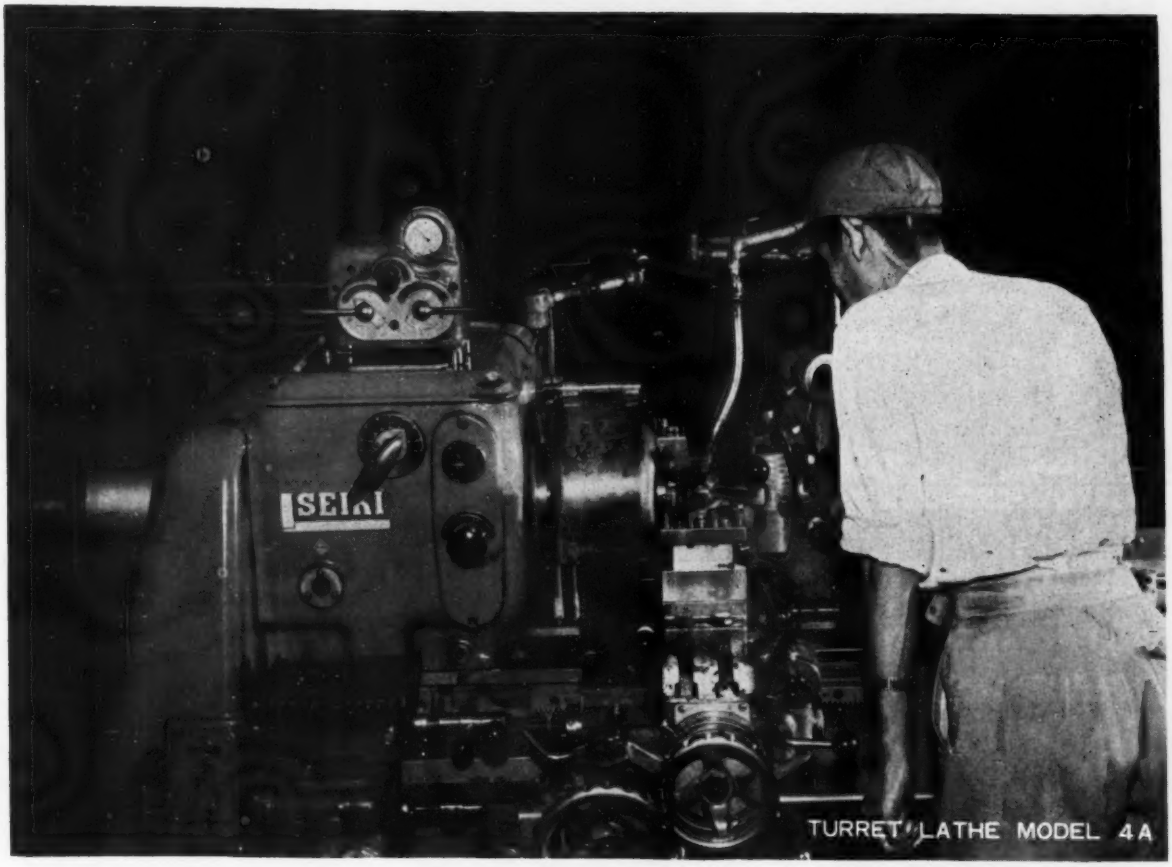
CARPENTER STEEL CO. has announced the start of construction on a new cold-rolled strip mill building at its West Shore property in Reading, Pa. The new facility, when completed, will replace existing cold-rolling capacity at the Reading plant.

The appointment of J. E. WILSON as general sales manager has been announced by ERIE FOUNDRY CO., Erie, Pa. In his new position, Mr. Wilson will direct domestic and international sales efforts for all of the firm's products, including steam and board drop-hammers, mechanical forging presses, and hydraulic presses.

WALTER IMBODEN has been made chief engineer of TEXTILE MACHINE WORKS, Reading, Pa. In this post, Mr. Imboden will have charge of the firm's Engineering Department and Development Laboratories.

TOM ZAWADZKI, group manager of the Polyvinyl Chloride Department of BORDEN CHEMICAL CO., has been appointed executive secretary of the newly formed PLASTICS INSTITUTE OF AMERICA, INC., Silver Spring, Md. He will be the institute's chief administrative officer. The Plastics Institute of America was incorporated in June as a nonprofit membership corporation to conduct fundamental research in plastics science and engineering, to carry on educational activities at the graduate-school level in these fields,

High Productivity with Precision and Economy...
Use Sturdy HITACHI SEIKI Machine Tools

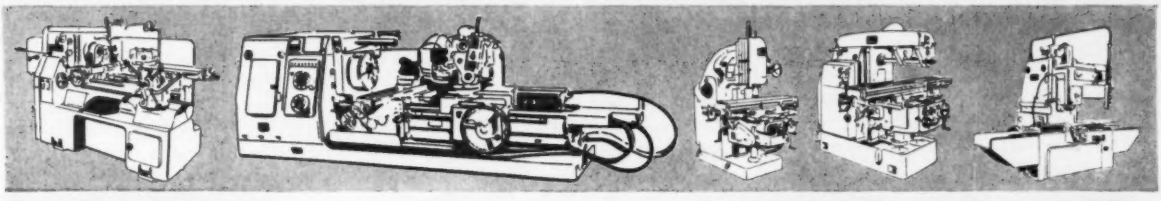


Best Prices and Fastest Delivery from Japan.

HITACHI SEIKI machine tools are designed and manufactured to meet the present day demands for high precision super-speed machining. Durability combined with high volume production assures low maintenance cost, conducive to profitable operations.

Machines include Turret Lathes, Milling Machines, etc.

HITACHI SEIKI MACHINE TOOLS



SEIKI

For detailed information, please contact

Sole Export Agent: **HAKKO CO., LTD.**

2, 2-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan

HAKKO CO., LTD. (Los Angeles): 4832 West Pico Blvd., Los Angeles

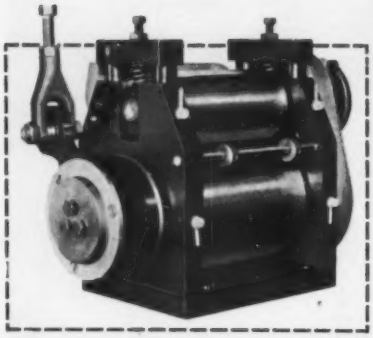
Kanematsu New York Inc. : 150 Broadway, New York 38, N. Y. Tel. No. Beekman 3-3890

For more data, circle this page number on Readers' Service Card

• Designed for high feeding accuracy!

• Extreme ruggedness!

• Increased pulling power!



benchmaster
AUTOMATIC PRECISION ROLL FEEDS

Accurately feeds measured lengths within a very few thousandths... Check this new series 3.5 PRF BENCHMASTER!

■ It employs a new roller cam type clutch that repeats uniformly on every stroke. Feed direction easily reversed. Strong pulling power is obtained by a heavy, adjustable spring load on each bearing block. Large lower roller produces full stroke length within a small operating arc *without use of gearing*, hence no backlash. Hollow roller construction overcomes inertial lag—increases operating speed. Feeds 0 to 3.5" per stroke. Stock widths: 3", 5", 7", 9". Speed: Up to 500 s.p.m.

ALSO AVAILABLE: Series 9 PRF; 0-9" feed length. Various stock widths.

Write for circular!

benchmaster

World's largest manufacturer of small punch presses and mills

1835 W. Rosecrans Ave. • Gardena, Calif.

Circle page number on Readers' Service Card

and to provide a comprehensive technical information and library service for its members.

Irvine B. Rabel, new president of American Machine Tool Distributors' Association

AMERICAN MACHINE TOOL DISTRIBUTORS' ASSOCIATION, Washington, D. C., has elected IRVINE B. RABEL president. During the past

C. Denson Day, vice-president, American Machine Tool Distributors' Association

year, Mr. Rabel, who is president of STAR MACHINERY CO., Seattle, Wash., served as vice-president of the association. C. DENSON DAY, president of MACHINERY ASSOCIATES, INC., Wynnewood, Pa., and WILLIAM L. WALKER, president of WALKER MACHINERY CO., Cincinnati, Ohio, have been elected vice-president and second vice-president, respectively. Mr. Day formerly served as second vice-president of the association. Mr. Walker, previously held the position of secretary-treasurer.

William L. Walker, second vice-president, American Machine Tool Distributors' Association

Tennessee

The appointment of KEITH SINCLAIR CO., INC., Nashville, Tenn., as a Carboloy cutting-tool distributor has been announced by METALLURGICAL PRODUCTS DEPARTMENT of GENERAL ELECTRIC CO., Detroit, Mich. The territory covered by the new distributor encompasses north- and south-central Tennessee and five counties in south-central Kentucky.

Texas and Louisiana

CLECO AIR TOOLS, a division of REED ROLLER BIT CO., Houston, Tex., has announced a realignment of its sales organization, elevating three of its sales officials to new positions. E. W. CLAYTON has been named director of marketing and sales. E. G. CLARK has been promoted to domestic sales manager, and J. G. HUDSON has been made distribution manager.

WEAKS SUPPLY CO., Monroe, La., has been appointed an authorized distributor of Carboloy cutting tools by METALLURGICAL PRODUCTS DEPARTMENT of GENERAL ELECTRIC Co., Detroit, Mich. The firm will serve the twenty-five northern parishes of Louisiana and fourteen counties in southeast Arkansas.

Japan

NATIONAL ACME CO., Cleveland, Ohio, has announced the signing of an agreement licensing MITSUBISHI

CAN YOUR PRECISION ITEMS
(big or little)
BE SOLD IN THE COMMON MARKET?

We are West German manufacturers of precision standard parts for cutting-tool-manufacture; we have a close-knit distribution network in West Germany and the rest of the Inner Six, calling on customers in the electrical, automotive, and metalwares industries.

Our organization has room to carry another exclusive line or two.

This is a most unusual opportunity to enter the rich European industrial market without heavy investment of money or time.

Write and tell us what you have to sell.

FISCHER-BRODBECK GMBH
Präzisionsteilefabrik
Weinsberg/Württemberg
Western Germany

For more data, circle Item 227A on Readers' Service Card

Used by thousands of leading plants throughout the world

Over 50 models

Lloyd
KOOLMIST
COOLANT GENERATOR

NEW—Koolmist Mist Coolant Generators ..... $ 9.95
NEW—Automatic Models $19.95
NEW—Concentrated Mist Coolant
- Only Coolant specially made for mist cooling
- No odors • Safe to use • Will not clog lines
- Will not rust machines

Free sample sent on request

LLOYD TOOL CORPORATION
1222-1224 N. Fair Oaks Pasadena, Calif.

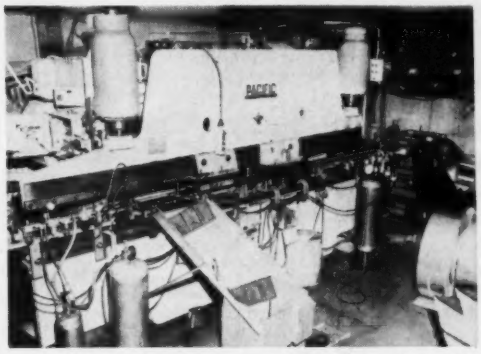
For more data, circle Item 227B on Readers' Service Card

B & R B
PRECISION BEARINGS
are manufactured to advance standards in the paths of progress for uninterrupted service and offer greater durability. Our catalog #20 will guide your selection listing many standard sizes which can be supplied without any costly delays. May we be of service in supplying your requirements?

THE BALL & ROLLER BEARING CO.
DANBURY, CONN.

For more data, circle Item 227C on Readers' Service Card

PACIFIC HYDRAULIC...THE FAST PRESS BRAKE produces 40 shingles per minute automatically



To match most production requirements, Pacific Hydraulic press brake can be set to a short stroke to eliminate all wasted motion and to cycle at high speeds. At Precision Industries, Honolulu, a single 150 ton Pacific produces, completely automatically, 40 shingles of 20 gauge aluminum every minute combining 7 separate operations with each stroke of ram. The press has an automatic feed including coil cradle, straightening roll, air slide feed, progressive dies and air ejector. Any plant, large or small, can handle a variety of jobs more economically on a Pacific.
Write for brochure.

PACIFIC PRESSES & SHEARS
848 - 49TH AVE., OAKLAND, CALIF.: also MT. CARMEL, ILL.

For more data, circle Item 227D on Readers' Service Card

NOW NEW
Slip Spindles ON ZAGAR HEADS
for drilling, reaming, tapping

Spindle locations can be changed quickly, easily, on Zagar gearless heads. Rigidity is retained in a compact, low height head. Varying patterns can be economically machined with one head, adaptable to any standard drill press.

A minimum of spindle extension keeps head height down.

WRITE FOR BULLETIN M-5711

23888 LAKELAND BLVD. • CLEVELAND 23, OHIO
Zagar INCORPORATED
USE MORE SPINDLES TO DO MORE WORK

For more data, circle Item 227E on Readers' Service Card

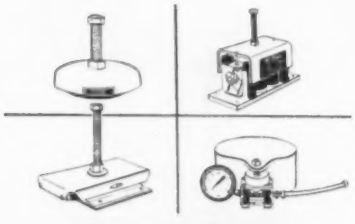
ARE YOU
JUST 4 FEET
FROM
EFFICIENCY?

If you have bolted the 4 (or more) feet of your machinery to the floor, you're missing the production efficiency that results from layout flexibility!

With your machinery feet on BARRYMOUNTS®, your own maintenance people can rearrange production lines *quickly*, and without worrying about shock, vibration or noise problems.

Only Barry can offer you *quality-engineered* machinery mounts to answer your particular needs. Three different resilient elements: neoprene, helical springs or air provide the versatility required for every mounting requirement. In addition, you get built-in leveling . . . machine mobility . . . and freedom from shock and vibration effects.

Barry's experience can help you gain higher production efficiency. Why not request a copy of Bulletin 60-04A, "Practical Considerations When Installing Machinery"?



BARRY
CONTROLS
SHOCK • VIBRATION • MACHINE EFFICIENCY
Division of Barry Wright Corporation
700 PLEASANT ST., WATERTOWN, MASS.
1400 FLOWER ST., GLENDALE, CALIF.
Circle page number on Readers' Service Card
228

SHIPBUILDING & ENGINEERING CO., LTD., Tokyo, Japan, to manufacture machine tools in that country. This agreement is subject to Japanese Government approval and covers models of Acme-Gridley multiple-spindle automatic machines.

Obituaries

A. C. Danekind

A. C. DANEKIND, who retired August 31 as assistant to the president of MAYTAG CO., Newton, Iowa, died on September 10 at the age of sixty-five. Assistant to the president since he joined the firm in 1948, Mr. Danekind became a company officer in 1949. At Maytag he undertook many special assignments involving the company's extensive expansion and modernization program. He was a key figure in the establishment of a market research division and a product-testing laboratory, and in the reorganization of MAYTAG CO. LTD., Winnipeg, Canada.

Dr. Oswald Kolbert

DR. OSWALD KOLBERT, technical director of WALDES KOHINOOR, INC., Long Island City, N. Y., died on September 20. He was sixty-two years old. Dr. Kolbert was born July 28, 1899, in the town of Nestemice, Czechoslovakia. He attended the Institute of Technology in Prague and was graduated as a chemical engineer in 1921. He began his career as a research laboratory engineer. From 1927 to 1932, he was employed as a market analyst for an electrical cable and rope company in Prague. In 1933, he acquired ownership of a company in Carlsbad which produced seamless steel tubing. He lost the business when the Germans occupied the Sudetenland in 1938. After a stay in England, he arrived in the United States, in 1940, and the following year joined Waldes Kohinoor, Inc., as a research and development engineer. He was appointed technical director of the firm, in charge of all engineering, in 1946.

Coming Events

NOVEMBER 1-3—Malleable Founders Society's Twelfth Annual Market Development Conference, to be held at the Hotel Sheraton-Cleveland, Cleveland, Ohio. For more information, contact the Malleable Founders Society, 781 Union Commerce Bldg., Cleveland 14, Ohio.

NOVEMBER 18—Annual Meeting of the Society of Carbide Engineers, to be held at the Belmont Plaza Hotel, New York City. For further information, contact Carl G. Erickson, national president, Society of Carbide Engineers, P. O. Box 45, Newington 11, Conn.

DECEMBER 1—Malleable Founders Society's Semiannual Meeting, to be held at the Hotel Sheraton-Cleveland, Cleveland, Ohio. For further data, contact the society at 781 Union Commerce Bldg., Cleveland 14, Ohio.

New Books

SCREW THREADS—DESIGN, SELECTION, AND SPECIFICATION. By Robert V. Mac Kenzie. 198 pages; 7 1/4 by 10 inches; 392 line illustrations. Published by THE INDUSTRIAL PRESS, 93 Worth St., New York 13, N. Y. Price, $9.50.

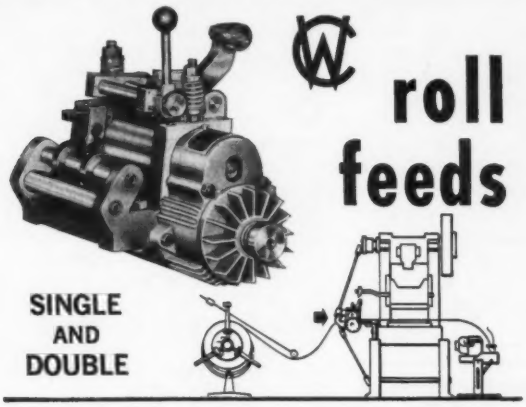
This treatise provides a complete and integrated treatment of that basic mechanical element, the screw thread. Although much has been written about screw threads in their various forms, and tables of standardized data are provided for almost every type, there is no single source where the reader can study in detail the design, selection, and specification aspects of all types of screw threads. This book has been written to meet that need.

It might be argued that with so much standard data available, there is no need for consideration of the design aspects of screw threads. A rapid perusal of this book will soon reveal many instances where screw-thread standards do not provide the answer to design considerations.

Two important requirements in good thread design and specification are clear, specific delineation and dimensioning. These factors are gone into thoroughly, and manifold examples of good practice are shown in detailed illustrations. For the reader who is not well versed in the language of screw threads, the chapter on Nomenclature, Definitions and Symbols will enable him to become rapidly acquainted with the terminology.

Another valuable feature of the book is that it presents a complete study of the interrelationship of the

FOR HIGH PRODUCTION STAMPING



W roll feeds

SINGLE AND DOUBLE

Cooper Weymouth Roll Feeds can push or pull coil stock into stamping presses at speeds up to 450 strokes per minute. Equipped with trouble-free high torque carbide clutch and disc type air cooled brake with twice the usual braking area. Fifteen standard sizes with feed length and stock width capacities up to 12".

Send for details on this and other Cooper Weymouth automatic production equipment for press rooms.

COOPER WEYMOUTH, INC.

603 Honeyspot Road, Stratford, Conn.

For more data, circle Item 229A on Readers' Service Card

ENLARGED SECOND EDITION!

MACHINERY'S MATHEMATICAL TABLES

Edited by Holbrook L. Horton

MACHINERY'S MATHEMATICAL TABLES has been serving mechanical engineers, machine designers, draftsmen, toolmakers, machinists and students for over 30 years! Now it is available in a greatly enlarged version, containing the authoritative, easy-to-use mathematical regular information you need on the job. Designed for speed and utility, you can now use its "edge index" to flip to any desired place in the book instantly.

The convenient pocket-size, its semi-flexible covers, and thin strong pages make it the ideal everyday reference book to have. 254 pages. $3.75

THE INDUSTRIAL PRESS, 93 Worth St., N. Y. 13

CAMS ALL TYPES MADE TO YOUR SPECS!

CAM CALCULATING SERVICE

Write for catalog 55-C

EISLER ENGINEERING CO., INC.
Chas. Eisler, Jr., President

738 South 13th Street
Newark 3, New Jersey

For more data, circle Item 229B on Readers' Service Card

For just $3.00 you get ANSWERS!

Answers to hundreds of questions. BEND? CUT? Then you should have in your library "A Manual of Processes for The Cold Bending of Metals and Abrasive Cut-Machining of Metals."

Order yours today

WALLACE MFG. COMPANY

1310 W. Diversey Parkway Chicago 14, Illinois

For more data, circle Item 229C on Readers' Service Card

HIGHEST DEGREE OF WRINGABILITY PLUS SUPERB WEAR-RESISTANCE

Justified by Time-honoured Experience And Ideal Facilities

TOYO GAUGE BLOCKS

TOYO GAUGE BLOCKS are mass produced under optimum facilities in environments completely air-conditioned to the industrial standard temperature of 68 F and relative humidity of 58%.

The use of cemented carbide Toyo Protector Gauge Blocks are recommended for longer gauge block life. They are available in increments from 0.05" to 0.2".

TOYO KOGYO CO.,LTD.

Main Office and Plant:
6047 Fuchu-machi, Aki-gun, Hiroshima, Japan

Tokyo Office:
6, 3-chome, Nihonbashi-Edobashi Chuo-ku, Tokyo, Japan

Osaka Office:
5, 5-chome, Minami-kyuhoji-machi, Higashi-ku, Osaka, Japan

For more data, circle Item 229D on Readers' Service Card

various thread elements and their influence on screw-thread design practice. Production characteristics, operating considerations, and selection factors are all analyzed from this same basic approach. In each design situation, whether it involves torsional deflection, fatigue and wear life, dynamic loading, or other considerations, the effects of helix angle, flank angle, thread form, lead, and pitch are studied in detail. Then, being aware of the relative effects of these different factors in many specific problems in screw-thread design, the reader is better able to capitalize on the strong points and subordinate the weak ones to his best advantage.

Special problems such as the impact of space technology and miniaturization on thread design and design problems in plastics and die-casting are touched upon; and a new approach is made in the analysis and evaluation of screw-thread gaging and inspection. In addition to fastening types of screw threads, those used for motion translation and power transmission are fully covered.

The importance of screw threads in our mechanized world of today makes this book an essential reference in every engineering school, technical institute, trade school, and industrial library. Here for the first time are brought together a wealth of data and information which could be previously obtained only by considerable hunting through a wide range of technical literature.

The topics covered in chapter form are: Historical Development of the Screw Thread; Nomenclature, Definitions, and Symbols; Principles of Delineation and Dimensioning; Basic Methods of Screw Thread Production; Thread Milling, Grinding, and Rolling; Basic Considerations in Thread Design; Designing Threaded Fasteners; Designing Translating Screws; Designing Threads for Special Applications; The Design of Nuts and Threaded Holes; and Thread Inspection and Quality Control.

INDUSTRIAL ORGANIZATION AND MANAGEMENT FUNDAMENTALS. By Herman B. Henderson and Albert E. Haas. 438 pages; 6 by 9 inches; eighty-one illustrations. Published by THE INDUSTRIAL PRESS, 93 Worth St., New York 13, N. Y. Price $7.50.

This text explains in a simple and clear manner the fundamental principles of industrial organization and management. It is free of details not pertinent to a basic approach to the subject and is particularly suitable for use by young men in college or those engaged in industry who wish to broaden their knowledge of the industrial field. In fact, it is an excellent reference for anyone who is planning to set up his own manufacturing business for the first time.

The basic factors to be considered in establishing a business to make a product—the preliminary survey to establish new-product possibilities, possible forms of business ownership, and the actual conditions for manufacture and marketing of the product—are all clearly set forth together with certain check points that should be adhered to.

Since the aim of every manufacturing business is to make a profit and to compete successfully with other businesses in the same field, special attention is given throughout the book to methods of reducing and controlling costs.

After a general introduction to the study of industrial organization and management with a brief glance at the historical background, the text covers, in logical fashion, the development and engineering of new products; the selection and arrangement of equipment for production and materials handling; the se-

COMPARE

and you'll get a BIG NEW Johnson model J

HEAVY DUTY METAL CUTTING BAND SAW

Capacity—10" rounds, 18" flats • Motor—¾ hp (Any voltage available) • Wheel Diameter—16" • Floor Space—66" x 31" • Bed—11" wide, 44" long, 6" deep, 24" high • Overall Height (closed)—39" • Weight—Approx. 750 lbs. • Speeds—36, 90, 130, 190 feet per minute.

COMPARE the handsome, husky Jonhson Model J with any metal cutting saw and here's what you'll find:

- Johnson leads the way in dependable, well-engineered, high performance band saws.
- A Johnson saw will cut anything in your stock pile, and do it faster.
- Johnson saws contain more exclusive construction and performance features that save time and money.
- Johnson saws are the finest metal cutting machines available anywhere—and, at the lowest price!

COMPARE . . . and see for yourself how easily you can save time, labor and production dollars with a Johnson saw. Complete information, prices—are yours for the asking.

Johnson MANUFACTURING CORPORATION
1016 BARNES ST., ALBION, MICHIGAN

Eastern Distributor	Midwestern Distributor	Western Distributor
R. J. R. KELLY CO.	W. Q. LUNDMARK	HASTINGS DISTRIBUTORS
Hale Bldg., 51 Main St.	75 N. Broadway	1605 Solano Avenue
East Orange, N. J.	Des Plaines, Ill.	Berkeley, Calif.

For more data, circle this page number on Readers' Service Card

lection of a plant site and buildings; financial planning for capital requirements; the establishment of maintenance and replacement policies; the nature of a manufacturing organization and the various possible patterns and designs; the need for good administrative leadership and the basis for sound industrial relations; the equitable administration of wages and salaries; the effective marketing of the product; the economical utilization of labor's time study; the establishment and application of work measurements; the planning and control of production; the methods of inventory control and purchasing; the functions of quality control; and various methods of cost control and reduction.

An extensive topical bibliography and an excellent working index are also provided. The conciseness and clarity of the text, together with the extensive graphs, charts, and diagrams supplied, make it easy for the student to grasp the fundamentals rapidly as they are presented and to acquire complete over-all understanding of how an industrial type business is organized and operated.

AMERICAN STANDARD TOLERANCES FOR BALL AND ROLLER BEARINGS. ASA B3.5-1960. 23 pages; 8 1/2 by 11 inches. Published by the American Standards Association, 10 E. 40th St., New York 16, N. Y. Price, $1.80

This standard establishes grades of precision for bearings used in all types of equipment. Tolerances are given for: radial ball bearings, airframe bearings, magneto ball bearings, thrust ball bearings, cylindrical roller bearings, spherical roller bearings, needle roller bearings, self-aligning roller bearings, tapered roller bearings, radial internal clearance of single-row radial ball bearings, snap-ring and groove dimensions, and tapered bore of radial ball bearings.

MACHINE TOOL METALWORKING. By John L. Feirer and Earl E. Tatro. 437 pages; 7 1/2 by 9 1/2 inches; illustrated. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. Price, $5.75.

This volume has been carefully developed as an introductory textbook on the machining of metals. It is not intended to provide comprehensive coverage of every aspect of machine-shop work. The book describes in detail only those operations which are of much value and are used frequently.

The authors have given complete step-by-step information on each major operation, which the student can follow directly from the book. The text, however, emphasizes broad concepts in regard to all machine tools. Students will remember comprehensive information longer, and use it more often, than detailed knowledge of a large number of unrelated operations. Therefore, the authors have devoted considerable space to such topics as how machines operate, what cutting tools are and how they shape metal, how to determine speeds and feeds, and the essentials of mechanics.

All important new words and terms are defined so that the student will quickly develop the vocabulary of the trade. The reading level of the volume has been carefully checked, moreover, so that it should be easy for students of high-school age to read and comprehend the text material.

To meet the objectives of a good machine tool metalworking course, the following subjects are covered: how to read drawings and prints, how to plan work, industrial information, occupational information, and data about basic materials.

For { 8-STATION PRODUCTION MACHINING
1½" BAR AND COLLET WORK
CHUCKING
SINGLE POINT THREADING

Costs { $7,525.00 FOB Factory Complete with all standard equipment

This is an all new 1½" bar capacity ram type turret lathe with power feeds to all 8 working stations . . . that in addition to bar and collet work also has the versatility to do chucking, and when needed, single point threading. Powered by a 5 h.p., two-speed, geared motor, the new Sheldon 3 R turret lathe provides 16 spindle speeds, 60 different feeds to the carriage and cross-slide, and 180 different feeds to the ram turret.
The turret itself is ruggedly built and accurately machined to provide close tolerance indexing. And for complete ease of operation, it is put under power by simply pressing a push button on the control panel.

This new 3 R Sheldon is completely equipped with two-speed motor and electrical controls, coolant system and splash guards, LO spindle nose, large satin chrome dials and hardened bed ways. It also provides an additional cost saving feature—each turret face is drilled and tapped for your standard flange type tooling as well as being bored for your standard 1½" shank type tooling.
For versatile, accurate machining in either long or short runs, the new Sheldon 3 R provides the answer to low investment cost with high profit operation.

New SHELDON
3R-TURRET LATHE

Write for bulletin with complete specifications and tooling data

SHELDON MACHINE CO., INC.
4246 N. Knox Ave. • Chicago 41, ILL.
Builders of 10", 11", 13", 15" Sheldon lathes, Sheldon Milling Machines, Sheldon Shapers and Sebastian Geared Head Lathes

Winners of Business Magazines Advertising Competition

Fifty-two company members of the National Machine Tool Builders' Association submitted 262 entries for twelve categories in the eighth annual business magazines advertising competition sponsored by the association. Presentation of the awards will be made at the annual meeting to be held November 15 to 17, at the Americana Hotel, Bal Harbour, Fla.

The winning companies and those receiving honorable mention are as follows:

1. Fractional page, black and white and two colors. First: Danly Machine Specialties, Inc., Chicago, Ill. Honorable mention: Danly Machine Specialties, Inc.; Reed Rolled Thread Die Co., Holden, Mass.

2. Single page, black and white. First: Greenlee Bros. & Co., Rockford, Ill. Honorable mention: Mattison Machine Works, Rockford, Ill. (two entries).

3. Single page, two colors. First: Gleason Works, Rochester, N. Y. Honorable mention: Cincinnati Miling Machine Co., Cincinnati, Ohio; Gleason Works; Michigan Tool Co., Detroit, Mich.

4. Two-page spread, black and white. First: Warner & Swasey Co., Cleveland, Ohio. Honorable mention: Barber-Colman Co., Rockford, Ill.; Warner & Swasey Co. (two entries).

5. Two-page spread, two colors. First: Armstrong-Blum Mfg. Co., Chicago, Ill. Honorable mention: Cincinnati Milling Machine Co.; National Acme Co., Cleveland, Ohio.

6. Single page in three or more colors, inserts and multiple pages more than two pages—in black and white or colors. First: Gisholt Machine Co., Madison, Wis. Honorable mention: Monarch Machine Tool Co., Sidney, Ohio; Norton Co., Worcester, Mass.

7. Catalogue describing a single machine. First: G. A. Gray Co., Cincinnati, Ohio. Honorable mention: American Tool Works Co., Cincinnati, Ohio; Monarch Machine Tool Co.; Pratt & Whitney Co., Inc., West Hartford, Conn.

8. Catalogue describing a line of machines. First: American Tool Works Co. Honorable mention: Besly-Welles Corporation, South Beloit, Ill.; Cincinnati Milling Machine Co.; Lodge & Shipley Co., Cincinnati, Ohio; National Acme Co.

9. General catalogue describing multiple lines of machine tools. First: National Acme Co. Honorable mention: Cincinnati Milling Machine Co.; Gisholt Machine Co.

10. Direct mail—best single mail piece. First: Gisholt Machine Co. Honorable mention: Denison Engineering Division, American Brake Shoe Co., Columbus, Ohio.

11. Complete program promoting a new machine tool. First: Landis Tool Co., Waynesboro, Pa.

12. Complete program—a corporate or institutional type program. First: Gardner Machine Co., Beloit, Wis. Honorable mention: Pratt & Whitney Co., Inc.

• • •

Film Stresses Better Grinding

A twenty-six-minute, sound, color film-strip, "Better Grinding," is available from the Landis Tool Co.,

CONSTANT SPEED UNDER LOAD
FROM 7,200 RPM TO 60,000 RPM!
Precise
2 HP
½ HP
¼ HP
1 HP
NEW SUPER CYCLE POWER QUILLS
Extend your range of precision grinding, milling and finishing—step into high production with the new line of Precise Super Cycle Power Quills. These new units provide constant speed operation with no speed drop under load . . . run at speeds from 7,200 rpm to 60,000 rpm . . . assure excellent surface finishes, longer life for abrasive wheels and carbide midget mills. Rotor has no windings, no commutator — never needs servicing. Super Cycle Power Quills (with converters) are available in four basic models — provide up to 2 hp output at the chuck. All Super Cycle Quills are interchangeable with Precise Universal Motor Power Quills.
CONVERTERS—Self-contained, portable converters for Super Cycle System. Single, four-speed and continuously variable models.
Precise
Grinder-Millers, Power Quills, Jig Grinders, Milling Machines, Automatic Drill Units, Cutting Tools, Vapor-Lub Cooling, Sklero Hardness Tester
Quality and Precision Since 1882
PRECISE PRODUCTS CORPORATION
37th Blue River Road, Racine, Wisconsin, U. S. A.
Branch Plant: Precise, G. m. b. H., Duesseldorf, Germany

For more data, circle Item 232A on Readers' Service Card

NEW from KERNS UNITED
K-6882 rust protective cleaner
cleans parts, guards against rust during processing and storage
This new alkaline compound by Kerns United has been developed primarily for power washer applications. It's a low foaming product that combines efficient cleaning of shop oils and dirt with effective rust protection of parts during processing or storage. It will not stain and is exceptionally easy to control.
2 Ounces of K-6882 per gallon of solution will protect parts against rust and stain longer than five days in 98% relative humidity.
Ask Kerns United for full details on the new K-6882 Alkaline Rust Protective Cleaner. And if you draw, cut, grind or forge metals, Kerns United has or can formulate a personalized lubricant that will save you production dollars. Call, wire, or write for information today.
KERNS UNITED Corporation
824 State Street • Calumet City, Illinois
Subsidiary: Kerns Pacific Corporation
630 N. Batavia St., Orange, Calif.
PERSONALIZED LUBRICANTS FOR INDUSTRY

For more data, circle Item 232B on Readers' Service Card

Waynesboro, Pa. Done in a cartoon style, "Better Grinding" describes and illustrates the "how to do it" for operators of cylindrical grinders. It should also be of interest to foremen of grinding departments, methods people, process engineers, training groups, and personnel concerned with the "do's and don'ts" of cylindrical grinding. There is no charge for its use.

(Continued from page 218)

in the sweat furnace is then removed and the process repeated. Built in sizes to handle from 200 to 2000 pounds an hour, and may be fired by gas, oil, or combination oil-gas.

Circle 628 on Readers' Service Card

PORTABLE PUNCH PRESS introduced by Modern Mfg. Co., Inc., Willow Grove, Pa., that exerts 6000 pounds but only weighs 17 pounds. Punch and dies can be easily replaced to punch out round, square, rectangular, or any shape hole up to 7/8 inch in diameter in 3/16-inch thick aluminum and 1/8-inch thick steel.

Circle 629 on Readers' Service Card

CARBURIZED STEEL ROLLS of uniform high hardness, of both tubular and solid types, are being produced by the Badall Co., Inc., Hammond, Ind. These rolls are made in sizes up to 48 inches in diameter by 24 feet in length, for use where wear resistance is an important requirement. They are especially treated to withstand thermal shock, warpage, breakage, and scaling. Tubular rolls can be carburized on either the inside or outside surface or both.

Circle 630 on Readers' Service Card

FEATHERWEIGHT WELDING TORCH with the shortest head of any torch in the Heliarc line introduced by the Linde Company, division of Union Carbide Corporation, New York City. This 2 1/2-ounce Heliarc HW-24 torch is specially designed for welding complex aircraft parts and any hard-to-reach joints. Average head length of just 1 inch (depending on cup size) enables an operator to weld in areas with only 1 1/4-inch clearance and permits improved view of the weld puddle.

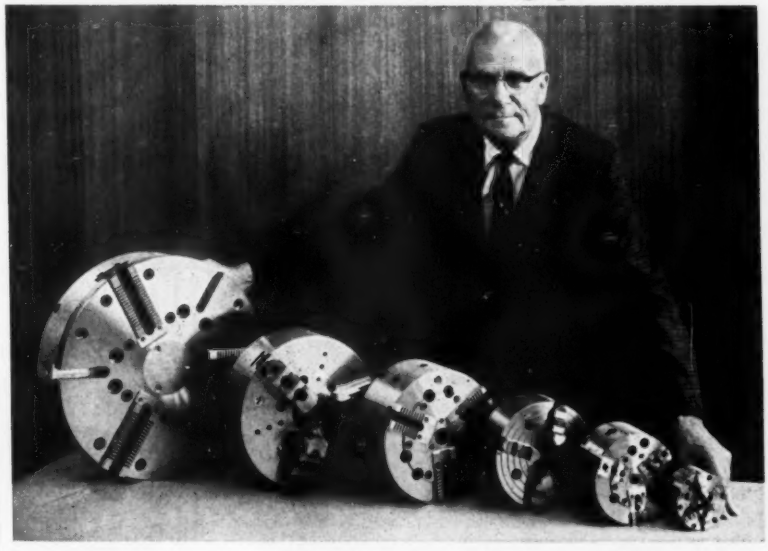
Circle 631 on Readers' Service Card

"FLUX-FLAW" equipment developed by Assembly Products, Inc., Chesterland, Ohio, for locating imperfections or discontinuities that formerly were undetectable in continuously moving metal. In extensive tests on metallic wire, sheet, and tubing the Flux-Flaw equipment has detected such elusive flaws as welds, holes, laminations, and other "voids," distinguishing between what it was seeking and other phenomena that cause unwanted signals, or "noise." Replaceable electronic modules adapt the unit to a variety of applications, employing several novel variations of familiar magnetic field techniques.

Circle 632 on Readers' Service Card

RIVETLESS BONDED BRAKE LININGS announced by the General Electric Co., Schenectady, N. Y., are now being marketed by the company's Industry Control Department, Salem, Va. Field trials have proved the new linings adaptable for heavy-duty steel mill and industrial applications. Important advantages shown by the trials include: longer lining life, no rivets to score brake-drums, brake-lining assemblies five times stronger than riveted types, 10 per cent greater braking surface due to elimination of rivet holes,

Here they are—the *Buck* chucks that solve most work-holding problems



Left to right:
6 of the 15 types of Buck chucks.

1. Aluminum power chuck with gibbed keyways
2. Dust proof chuck
3. Steel Power chuck, Serrated Jaws
4. Independent chuck
5. Steel Power chuck, American Standard
6. 6 jaw Ajust-Tru

Ready to cut your machining costs

You start saving—on production or in the tool room—the day you put Buck Ajust-Tru chucks to work.

MANUAL chucks adjust for dead true precision in a minute — *guarantee .0005" precision chucking duplicate parts.*

POWER chucks—steel or aluminum body, regular or serrated jaws—*guarantee precision within .001"* and provide many other exclusive operating savings.

It's the unique, patented Buck Ajust-Tru principle that makes Buck chucks so different—*at no price premium.* It'll be well worth it to get full details.

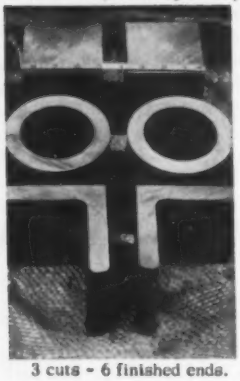
NEW Catalog 61 ready—write for it.

BUCK TOOL COMPANY

1120 SCHIPPERS LANE • KALAMAZOO, MICH.

WHAT'S YOUR SHOP COST PER HOUR FOR WAGES AND OVERHEAD?

If it's $6.00 you spend 10 cents per minute.
If it's $7.20 you spend 12 cents per minute.



3 cuts - 6 finished ends.

Cuts like these are made in SECONDS!

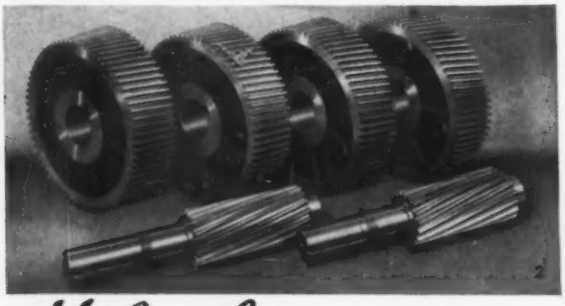
$6.00 per hour = 1/6 cents per second.

$7.20 per hour = 1/5 cents per second.

WHEN YOU CAN CUT AND FINISH LIKE THIS (Total time 58 seconds) THAT'S FAST! WHY DON'T YOU INVESTIGATE TO SEE WHAT YOU ARE MISSING.

Write and ask about "Cut-Machining."

WALLACE SUPPLIES MFG. COMPANY
1310 W. Diversey Parkway, Chicago 14,
Or ***Check Item 234A*** *on card.*



Helical
GEARS AND PINIONS

SPURS TO 72" PD. 1 DP
BEVELS TO 54" PD. 1 DP
SPIRAL, HELICAL and WORM GEARS TO 48" PD. 2 DP
CONTINUOUS TOOTH HERRINGBONE TO 60" PD. 2 DP
SPROCKETS TO 72" PD. 2½" CP
RACKS TO 20 FT. LONG. 3 DP
SILENT GEARS RAWHIDE, BAKELITE, FIBROIL
HEAT TREATED CASE OR FLAME HARDENED GEARS— OF CARBON OR ALLOY STEEL

Ready for long, trouble-free use in bar straightening equipment, these precise examples of Stahl's craftsmanship in gear fabrication have been double-checked for strict compliance with specifications. Illustrated are 4 steel helical gears—24.697" F., 72 T., 3 D.P., together with 2 Hyten B3X steel shaft pinions 6.758" O.D., 16¾" F., 35" Length-over-all. Heat treated. Let Stahl end your gear worries—send for our estimate.

Stahl
GEAR & MACHINE COMPANY
3901 HAMILTON AVENUE
CLEVELAND 14, OHIO

For more data, circle Item 234B on Readers' Service Card

ALVA ALLEN
HEAVY DUTY PUNCH PRESSES

Model BT-5-DR 5-Ton Double Ram Press

Model BD-3 3-Ton Deep Throat Press

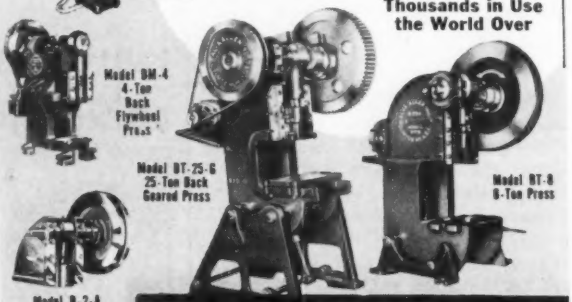
See Yellow Pages for Local Distributor

POWERFUL—DEPENDABLE FULLY GUARANTEED MODERATE IN PRICE

1 to 25 Ton Capacity Presses in Hundreds of Different Model Combinations

Including accessories — Motors and Controls, Dial Index Feeds, Air Clutch-Brake Units, Safety Equipment, Friction Roll Feeds, Punch and Die Units, etc.....

Thousands in Use the World Over



Model BM-4 4-Ton Back Flywheel Press

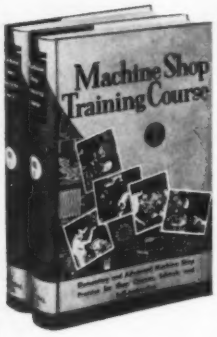
Model BT-25-G 25-Ton Back Geared Press

Model BT-8 8-Ton Press

Model B-2-A 2-Ton Nail Press

ALVA ALLEN INDUSTRIES, Dept. M
Clinton, Missouri Tel. TUrner 5-3331

For more data, circle Item 234C on Readers' Service Card



MACHINE SHOP TRAINING COURSE

By FRANKLIN D. JONES

This standard treatise on machine shop practice is in two volumes which may be used independently, but which together contain the most complete existing work on machine shop practice and allied subjects.

MACHINE SHOP TRAINING COURSE contains over 1000 pages of questions and answers, carefully selected to deal with the most important elements of machine shop practice, and with other subjects closely allied to work in the shop. The answers in each case cover clearly and fully the essential points and average about one book page in length. They are packed with useful facts and shop rules, and are accompanied by clear drawings and photographs whenever needed.

This is for the shop man who wants to supplement his own experience with a broad fund of practical knowledge, for use as a textbook and guide in shop training courses, for technical or trade schools, for designers and production engineers who want the fundamentals of machine shop practice and for mechanical engineering students.

Vol. 1, 570 Pages, $5.50
Vol. 2, 554 Pages, $5.50
Complete Two Volume Set $9.00

To Order, See Last Page

VADEN VANISOUL

New Epoch making Additive in the preparation of Water-Soluble Grinding Fluid.

By adding 1% in volume of VADEN VANISOUL to water, a splendid grinding fluid, excellent both in anti-rust and machining capacities, will be produced.

This fluid guarantees the most precise and cleanest finish to the metal work surfaces, while improving the grinding efficiency.

(For further Technical Literature please apply to us)

VADEN

SATO SPECIAL OIL CO., LTD.
30, 3-CHOME, IMAFUKU-NAKA, JOTO-KU, OSAKA, JAPAN
TEL. OSAKA (33) 2974 • 4090

For more data, circle Item 235A on Reader's Service Card

DYKEM STEEL BLUE

Stops Losses making Dies and Templates

Popular package is 8-oz. can fitted with Bakelite cap holding soft-hair brush for applying right at bench; metal surface ready for layout in a few minutes. The dark blue background makes the scribed lines show up in sharp relief, prevents metal glare. Increases efficiency and accuracy.

Write for sample on company letterhead

THE DYKEM COMPANY
2303R North 11th St. • St. Louis 6, Mo.

CUT SCRAPER TIME

END NIGHT CLEANUP & MORNING REBLUING

DYKEM HI-SPOT BLUE No. 107 is used to locate high spots when scraping bearing surfaces. As it does not dry, it remains in condition on work indefinitely, saving scraper's time. Intensely blue, smooth paste spreads thin, transfers clearly. No grit; noninjurious to metal. Uniform. Available in collapsible tubes of three sizes. Order from your supplier. Write for free sample tube on company letterhead.

THE DYKEM CO., 2303R NORTH 11TH ST., ST. LOUIS 6, MO.

For more data, circle Item 235B on Readers' Service Card

GEARS—ALL MAKES . . . Special and standard

PRECISION GEARS UP TO 200 DIAMETRAL PITCH

All Gears certified for Accuracy
Quality and Fine Workmanship

NEW JERSEY GEAR & MFG. Co.
1470 Chestnut Ave. **Hillside, N. J.**

For more data, circle Item 235C on Readers' Service Card

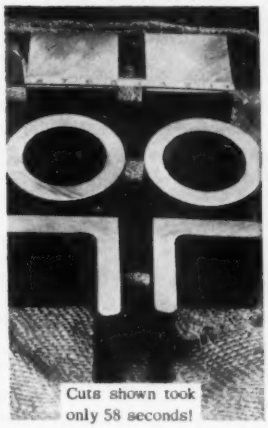
ARE YOU

WORKING OVERTIME TO KEEP YOUR PRODUCTION LINE FULL?

ARE YOU running more than one HACK OR BAND SAW?

Then you cannot afford to remain in the dark.

3 cuts - 6 finished ends.



Cuts shown took only 58 seconds!

with WALLACE "CUT-MACHINING."

YOU CAN

CHANGE MINUTES into SECONDS!

Write! Learn how it's done.

WALLACE SUPPLIES MFG. CO.
1310 W. Diversey Parkway
Chicago 14, Illinois

Or *Check Item 235D* on card.

NEW INFORMATION for every tool and diemaker!

The new edition of TOOL STEEL SIMPLIFIED gives you proved job-help found in no other book! • Put your toolroom on a profitable, competitive basis • Reduce heat treating failures • Improve tool and die performance • Lower diemaking costs • Take the guesswork from tool steel selection • Double check your tooling procedures • Train new men faster • Get more consistent results • Advance faster in your job • ORDER NOW!

23 chapters
596 pages
349 illustrations

PRICE ONLY $2.50
(Postpaid in U.S.A. Elsewhere $3)

The Carpenter Steel Company, Reading, Pa. Dept. 2

Please send the NEW Tool Steel Simplified at low price of $2.50 ($3.00 outside U. S. A.) in full payment. Check or money order enclosed.

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____
(please print)

For more data, circle Item 235E on Readers' Service Card

and elimination of maintenance operations required in riveting replacement linings. The bonded linings are now standard equipment on General Electric's Type IC9528 brakes and are interchangeable with riveted linings on all IC9528 brakes. Replacement of the new bonded linings requires no disassembly of the brake or demounting of brake-shoes.

Circle 633 on Readers' Service Card

PORTER-CABLE 1/2-INCH DRILL that is said to be more than 5 pounds lighter and 4 inches shorter than most regular industrial drills of the same capacity has been introduced by Rockwell Mfg. Co.'s Power Tool Division, Pittsburgh, Pa. Designed for builders, electricians, plumbers, mechanics, and maintenance men, this low-cost Model 372 drill features a heavy-duty 3.6-ampere motor and all ball-bearing construction. It weighs only 5 pounds, has a speed of 750 rpm, and will drill 1/2-inch holes in steel and 1-inch holes in wood.

Circle 634 on Readers' Service Card

HEAT-TREATED ALLOY-STEEL STUDS in eight sizes ranging from 1/4 to 1 inch in diameter and lengths up to 12 inches are now being manufactured by Jergens Tool Specialty Co., Cleveland, Ohio. These double-drawn and heat-treated studs are designed to prevent thread distortion and stud failure. They have a tensile strength of more than 125,000 psi and are used principally in tool and die work for machine and fixture setups.

Circle 635 on Readers' Service Card

HAND-OPERATED ARBOR PRESS for electronic and subminiature assembly work, which has a 5 1/4-inch inside height and a 2 1/2-inch working throat depth, made by Acratool, Inc., Ontario, Calif. This press has been designed for riveting, seating bearings and bushings, and wire cutting. It also has many versatile applications for prototype, experimental, or job-shop work. The 5/8-inch diameter arbor is concentric with a 1-inch hole in the base.

Circle 636 on Readers' Service Card

UPSET TESTER FOR COLD-HEADING MILD STEEL, consisting of two companion units of hydraulic equipment, brought out by the Manco Mfg. Co., Bradley Ill. One unit cuts slugs of the metal to the required length and the other does the actual upset testing. Diameters from 3/16 to 3/4 inch can be accommodated. Slugs cut by the shear are placed in an enclosed chamber in the upset tester. A hydraulically operated ram then performs the upset test in about two and one-half seconds. Any percentage of upset desired may be obtained through an adjusting wheel. Both units are powered by a single electric motor-driven pump.

Circle 637 on Readers' Service Card

HUGE DIE-CASTING MACHINE rated at 1300 tons of die-locking force and said to be the largest ever built announced by the Kux Machine Co., Chicago, Ill. This equipment has been tested to 1600-ton locking force and is designed for producing the largest and most complex aluminum castings to the highest degree of tolerance, structural density, and finish. Gasoline engine blocks, automotive transmission housings, large control cabinets, gear-boxes, and lawn-mower covers are typical products.

Circle 638 on Readers' Service Card

PRESS FOR FORMING CONVEYOR ROLLS automatically at high speed announced by Trimble Mfg. Co., Inc., Libertyville, Ill. Steel conveyor rolls up to 2 1/2 inches in diameter and 48 inches in length can be made on this heavy-duty hydraulic press. This Model 150-AF press forms both ends of 700 tubular steel conveyor rolls per hour. A second press, Model 150, the same as the Model 150-AF except that loading and unloading are handled manually, is also available.

Circle 639 on Readers' Service Card

PORTABLE POWER CUTTERS of new series "Pneudraulic" (air-operated hydraulic) hand-held type, including three sizes capable of delivering up to 27 1/2 tons of cutting force, announced by Chicago Pneumatic Tool Co., New York City. Designed for snipping reinforcing bars, alloy-steel rods, and bolts up to 1-inch diameter. Powered by a remotely controlled, portable power cell mounted on casters and light

North Rhine-Westphalia

Well-known sales company in North Rhine—Westphalia with staff of engineers and a well established branch network intends to expand and round off its field of activity. It is interested in taking over the sale and possible manufacture of

a first-class machine element

preferably in the power drive field, under general license for the Federal Republic of Germany or for West Europe. Reply to: Box 735. Machinery Magazine, 93 Worth Street, New York 13, N. Y.

CLASSIFIED ADVERTISING
Sold at $16 Per Column Inch

— new 4th printing —
MACHINE TOOL RECONDITIONING
& the Art of Hand Scraping
Send for free folder describing illus. book.
MACHINE TOOL PUBLICATIONS
215 Commerce Bldg., South Wabash St.
St. Paul 1, Minn.

enough to be carried anywhere. This power cell converts normal shop air pressure into hydraulic pressures up to 7000 psi.

Circle 640 on Readers' Service Card

MAGNETIC HOLD-IN SWITCH of small size, with both solenoid and switch enclosed in 1-inch diameter sealed housing, introduced by the Micro Switch Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. When toggle lever is operated and solenoid-energized, the lever stays in the actuated position until it is released manually or electrically by de-energizing the solenoid by remote control. Electrical rating of this double-pole, double-throw switch is 28-volt direct current at 24 amperes.

Circle 641 on Readers' Service Card

INTENSE-HEAT MITT designed to solve specific problem involving the safe handling of red-hot metal bars at over 1000 degrees F. brought out by Advance Glove Mfg. Co., Detroit, Mich. This mitt was originally developed to provide a safe, durable, flexible, and comfortable heat mitt for an industrial plant where 5-foot long bars, formed at over 1000 degrees F., were handled at twenty- to thirty-second intervals for approximately ten to fifteen seconds.

Circle 642 on Readers' Service Card

CIRCULAR-SAW SETTER that assures uniform setting of the teeth by means of a precision trip-hammer announced by Foley Mfg. Co., Minneapolis, Minn. Designated Model 359, this setter accommodates all circular saws from 5 to 38 inches in diameter. Teeth may be set for rip, cross-cut, or combination sawing. The force of the hammer blow may be varied from very light for thin-gage blades to exceptionally powerful blows for heavy-gage blades with thick, coarse teeth.

Circle 643 on Readers' Service Card

PRECISION GARTER SPRINGS featuring patented end connection announced by Associated Spring Corporation, Bristol, Conn. These springs are available in a wide range of commercial sizes in compression and extension types. They extend the range of uses for garter type springs into the area of exacting high load and severe service applications.

Circle 644 on Readers' Service Card

ELECTRONIC MONITOR of desk-top size with bar chart recorder, which can monitor and graphically record the operation and indicate the efficiency of up to forty production or data-processing machines, manufactured by Electronic Associates, Inc., Long Branch, N. J. This device is designed for remote operation and provides cost and production control information on a continuous chart. Minute-by-minute monitoring pinpoints lost time due to breakdowns, poor scheduling, tardiness in starting, and absences.

Circle 645 on Readers' Service Card

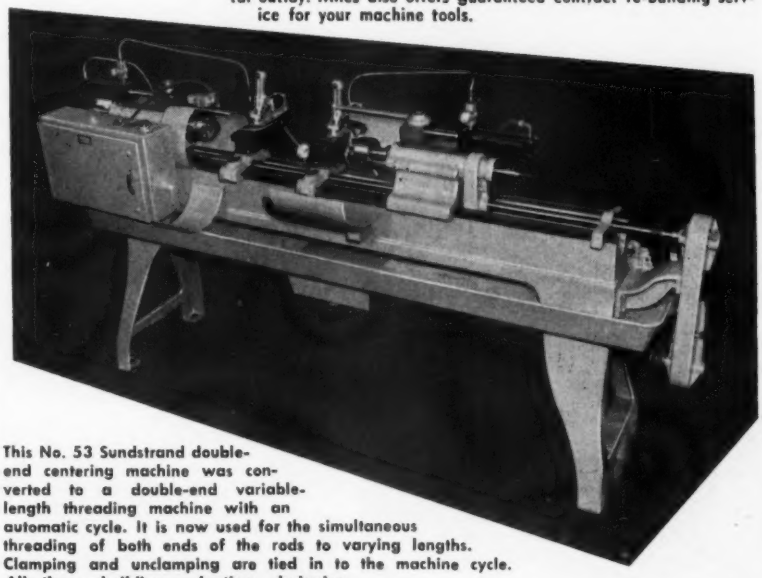
LOAD CELL designed for precise control of machine tools and materials-handling processes announced by Force Controls Co., Ferndale, Mich. This device, trade-named "Force Control Cell," is actuated by deflections as small as 0.001 to 0.005 inch. Typical applications include: detection and control of roll pressures, punch-press forces, die wear, dull drills, sheet thicknesses, press-fit forces, and welding-electrode pressures. Available in sixteen models with capacities ranging from 500-1000 to 75,000-500,000 pounds of force. One-knob control can be preset at any desired load, or two-knob control can be had for high-low or "Go" and "Not Go" type of control. Control knobs read directly in pounds of force.

Circle 646 on Readers' Service Card

NOW! COMPLETE MACHINE TOOL SERVICE AT MILES

- **RE-DESIGNING AND/OR RE-TOOLING**
- **GUARANTEED RE-BUILT MACHINE TOOLS**
- **NEW AND GUARANTEED USED TOOLS**
- **CONTRACT RE-BUILDING OF YOUR MACHINE TOOLS**

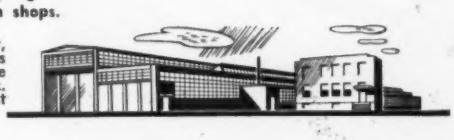
All of Miles re-built machine tools are tested under load and guaranteed to operate to new tool tolerances. In re-building, Miles frequently adds modern features, too, such as non-metallic and hardened steel wearing plates, up to date control systems, etc. In addition, Miles designs and builds special tooling for machine tools to do specific jobs. With guaranteed tools from Miles . . . you can increase the capacity and efficiency of your plant with minimum capital outlay. Miles also offers guaranteed contract re-building service for your machine tools.



This No. 53 Sundstrand double-end centering machine was converted to a double-end variable-length threading machine with an automatic cycle. It is now used for the simultaneous threading of both ends of the rods to varying lengths. Clamping and unclamping are tied in to the machine cycle. All the re-building, adapting, designing and tooling were done in Miles' own shops.

MILES

Over 1000 new, used and Miles re-built machine tools in stock. Write for latest stock list.

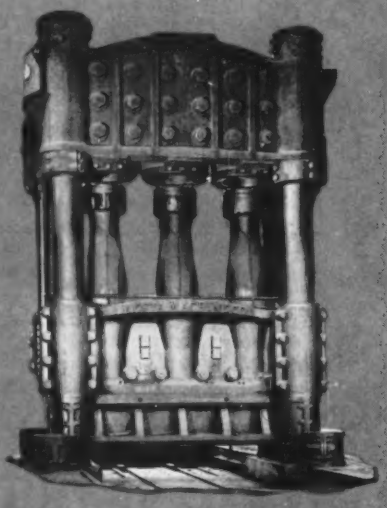


MACHINERY COMPANY, 2045 E. Genesee Ave., Saginaw, Michigan

FOR SALE FROM STOCK

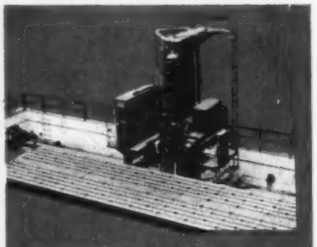
Unusual surplus machine tools.
All Equipment maintained in excellent condition.

LIPSETT DIVISION
LURIA BROTHERS & COMPANY, INC.
P. O. Box 8337
So. Charleston 3, W. Virginia
Phone Area Code 304 RI. 4-9434
Write for our Free Catalog

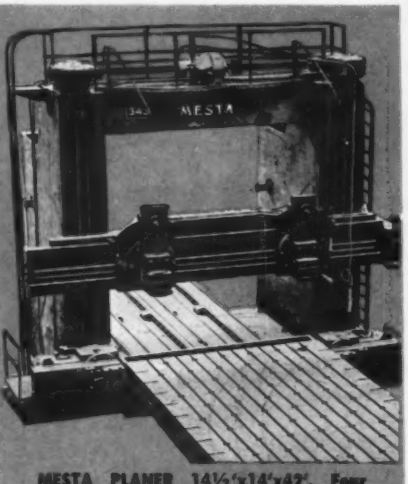


14,000 Ton MESTA PRESS 3 cyl. 18' Daylight, Dist. Bet. Cols. 19'x8'6", Stroke 10', 6300 PSI Hydro-Pneumatic Operation Transf., Starting Equip., & all Misc. Aux. Equip.

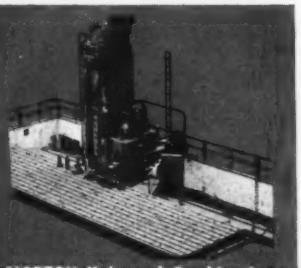
6,500 Ton UNITED HYDRAULIC PRESS, Stroke 10', Daylight 19'4", Dist. Bet. Cols. 18'5"x7'4", 4500 PSI Hydra-Pneumatic Accumulator System with Pumps, Pressure Vessels, Transf. Starting Equip. & all Misc. Aux. Equip.



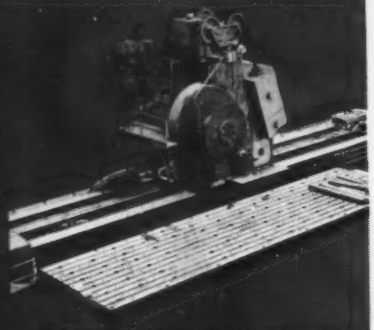
INGERSOLL 12'x46' Universal Traveling Housing Type Boring & Milling Machine.



MESTA PLANER 14½'x14'x42'. Four Heads, 150 HP Variable Voltage Drive. NILES PLANER 15'x14'x36', Four Heads, 150 HP Variable Voltage Drive. (4 of each available)

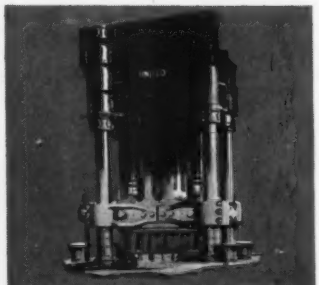


MORTON Universal Combination, Boring, Drilling, Milling Machine and Draw Cut Planer. 13'x46', 10¾" Spindle.



NEWTON 120"x46' Combination Rotary Planer & Cold Saw.

6,500 Ton MESTA PRESS Down Moving Hydraulic Bending, 4 Rod Type, with Self Contained Pumping Units, Bed arranged with hydraulic front to rear travel to facilitate loading and unloading if desired. Bed 15'x15', ram 7'16"x 16" stroke 60", daylight 84", diam. of rods 24".
3000 ton CLEARING HYDRAULIC PRESS. Model H-3000-60, Down moving, 18" Stroke, Self contained, Bed 60"x7'4" 1952.
2500 ton BLISS HYDRAULIC PRESS type HS-2500H-66x66, Hydro-dynamic, Down moving, stroke 24", Bed 66"x66", Self contained, 1952.



14,000 Ton UNITED ENGINEERING PRESS, 4 col., 2 Ram Type, Stroke 10', Dist. Bet. Cols. 23'x 11'6", Daylight 22' 4500 PSI Hydro-Pneumatic Accumulator Syst. with Pumps, Pressure Vessels, Transf., Starting Equip. Misc. Aux. Equip.

Alphabetical Index of Advertisers

A

Allen, Alva, Industries 234
Allen-Bradley Co. 197-198
American Oil Co. 54-55
Anaconda American Brass Co. 69
Armstrong-Blum Mfg. Co. ... 215
Armstrong Bros. Tool Co. ... 22
Avey Div., Motch & Merry-weather Machinery Co. 200

B

Barry Controls Div., Barry Wright Corp. 228
Ball & Roller Bearing Co. 227
Barber-Colman Co. 46-47
Barnes Drill Co. 49
Baush Machine Tool Co. 72
Beatty Machine & Mfg. Co., Quickwork Div. 218
Benchmaster Manufacturing Co. 226
Bethlehem Steel Co. 219
Birdsboro Corp. 32
Blanchard Machine Co. 58
Bliss, E. W., Co. 37
Bryant Chucking Grinder Co. 181
Buck Tool Co. 233
Bullard Co. 209
Burgmaster Corp. 16-17, 202

C

Capewell Mfg. Co. Inside Back Cover
Carpenter Steel Co. 235
Chicago Pneumatic Tool Co. 204-205
Cincinnati Gear Co. 151
Cincinnati, Milling Machine Co., Special Machine Div. .. 6-7
Cincinnati Milling Products Div., Cincinnati Milling Machine Co. 41
Cincinnati Shaper Co. 201
Circular Tool Co., Inc. 185
Classified Advertisements 236-238
Clearing Div., U.S. Industries, Inc. ..... Back Cover
Cleveland Crane & Engrg. Co. 68
Cooper Weymouth, Inc. 229
Cross Co. 179

D

Danly Machine Specialties, Inc. 199
DeLaval Steam Turbine Co. .. 70
DeVlieg Machine Co. 14-15
Diehl Mfg. Co. 189
DoAll Co. 173
Dykem Co. 235

E

Edlund Machinery Co. 217
Eisler Engineering Co. 229
Eldorado Tool & Manufacturing Corp. 223
Engis Equipment Co. 214
Ex-Cell-O Corp. ... 21, 23, 25, 27

F

Federal Press Co. 171
Fellows Gear Shaper Co. 4-5
Friden, Inc. 24
Fischer-Brodbeck GMBH 227

G

Gallmeyer & Livingston Co. 210-211
Gardner Machine Co. 19
Gisholt Machine Co. 52
Gleason Works 28-29
Goss & DeLeeuw Mch. Co. 206
Gray, G. A., Co. 12-13
Greaves Machine Tool Co. 161
Greenfield Tap & Die Div., United Greenfield Corp. 207
Greenlee Bros. & Co. 44
Gulf Oil Corp. 142-143

H

Hakko Co., Ltd. 225
Hamilton Tool Co. 216
Hardinge Brothers, Inc. 74
Heald Machine Co., The Inside Front Cover

I

Illinois Tool Works, Inc. 195
Induction Heating Corp. 175
Industrial Distributors (Sales), Ltd. 66-67
Inland Steel Co. 31

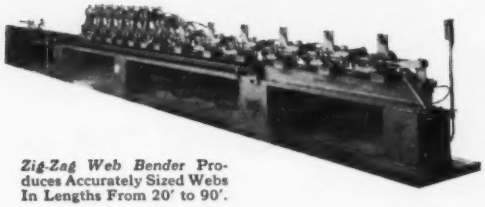
J

Jacobs Manufacturing Co. ... 76
Johnson Manufacturing Corp. 230

K

Kent-Owens Machine Co. 183
Kerns United Corp. 232

NOW YOU CAN MAKE A ZIG-ZAG® WEB IN JUST 60 SECONDS*



Zig-Zag Web Bender Produces Accurately Sized Webs In Lengths From 20' to 90'.

The Zig-Zag Web Bender obsoletes every other method of producing webs for joists by bending webbing faster and with greater accuracy.
One or two men can operate the Zig-Zag Web Bender and produce several times the output possible with old fashioned bending.
Depth, pitch and radius of bends are precise and consistent in their precision in every bend, resulting in fewer slow-ups on the welding line.
For complete technical details on the Zig-Zag Web Bender write to:

*10' Long—16" High—12" Pitch

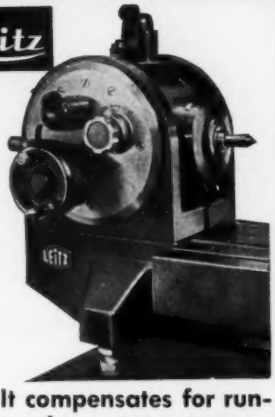
National Bending Machinery Corp.
104 STATION STREET • JOHNSTOWN, PA.

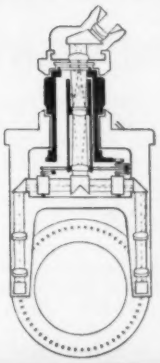
For more data, circle Item 239A on Readers' Service Card

ULTRA PRECISION IN SPACE

Leitz

Ultra Precision Spacing on guided missile components and similar critical work guaranteed by this exclusive DOUBLE-MICROSCOPIC PICK-UP of the LEITZ OPTICAL MASTER DIVIDING HEAD.





It compensates for run-out, the most common source of error. Working accuracy ± 1 second of arc.

There is no substitute for LEITZ in optical dividing.

Request catalog 82-1

OPTO-METRIC TOOLS, INC.
137 M VARICK STREET, NEW YORK 13, N. Y.

For more data, circle Item 239B on Readers' Service Card

Alphabetical Index of Advertisers

L

Lamb, F., Jos., Co. 168-169
Landis Machine Co. 2-3
Landis Tool Co. 8-9
LaSalle Machine Tool, Inc. ... 53
Leland-Gifford Co. 57
Lloyd Tool Co. 227
Lucas Machine Div., New Britain Machine Co., The 59-60
Luria Bros. & Co., Inc. 238

M

Macklin Co. 61
Malleable Castings Council 186-187
Mattison Machine Works 45
Metallurgical Products Dept., General Electric Co. ... 192-193
Michigan Special Machine Co. 166
Michigan Tool Co. 191
Micro-Poise Engineering & Sales Co. 39
Micromatic Hone Corp. 213
Miles Machinery Co. 237
Moore Special Tool Co., Inc. .. 30

N

National Acme Co. 35
National Bending Machinery Corp. 239
National Broach & Machine Co. 56
National Machinery Co. 224
Nebel Machine Tool Corp., Lathe Div. 203
New Britain Machine Co., The, Lucas Machine Div. 59-60
New Britain Machine Co., The, New Britain-Gridley Machine Div. 68A-68B
New Jersey Gear & Mfg. Co. .. 235
New Jersey Zinc Co. 26

O

Oliver Instrument Co. 155
Opto-Metric Tools, Inc. 239
Orban, Kurt, Co., Inc. 153
Osborn Manufacturing Co. .. 222

P

Pacific Presses & Shears 227
Pangborn Corp. 240
Pipe Machinery Co. 40
Pratt & Whitney Co., Inc. ... 33
Precise Products Corp. 232

R

Revere Copper & Brass, Inc. 62-63
Ross Operating Valve Co. 149
Ruthman Machinery Co. 190

S

S-P Manufacturing Corp. 212
Sato Special Oil Co., Ltd. 235
Schmidt, Geo., T., Inc. 188
Scully-Jones & Co. 71
Sheldon Machine Co., Inc. 231
Sheffield Corp. 42
Shore Instrument & Mfg. Co. . 176
Snyder Corp. 163
South Bend Lathe, Inc. 221
Stahl Gear & Machine Co. 234
Standard Tool Co. 196
Starrett, L. S., Co. 157
Stuart, D. A., Oil Co., Ltd. ... 165
Sundstrand Machine Tool Co., Div. Sundstrand Corp. ... 48, 50

T

Texaco, Inc. 34
Textile Machine Works 18
Timken Roller Bearing Co. Front Cover, 51
Toyo Kogyo Co., Ltd. 229

U

U.S. Industries, Inc. .. Back Cover
United Greenfield Corp., Greenfield Tap & Die Div. 207
United States Drill Head Co. .. 38
Universal Engineering Co. ... 36

V

Verson Allsteel Press Co. 20

W

Wallace Mfg. Co. 229
Wallace Supplies Mfg. Co. . 234-235
Warner & Swasey Co. 10-11
Wesson Corp. 64-65
Wheelock, Lovejoy & Co., Inc. . 208
Whitman & Barnes, Inc. 147
Wickes Machine Tool Div., Wickes Corp. 159
Winslow Products Engineering Corp. 194

Z

Zagar, Inc. 227

Aluminum motor housing BEFORE Vibratory Finishing
Vibratory Finishing by Pangborn
Aluminum motor housing AFTER Vibratory Finishing

AMAZING, HOW INEXPENSIVE COMPLEX FINISHING CAN BE

In some cases, the Pangborn Vibratory Finishing Machine has reduced finishing time by over 90%. You know what this means in time and labor savings alone. Especially since this machine tackles complex finishing assignments with the same ease and speed as simple ones.

Its uses are amazing, too. It descales, deburrs, burnishes, radiuses, fine-finishes. It handles a wide variety of materials . . . metals, plastics and ceramics. And this machine tackles complex and difficult jobs impossible or impractical to do by other methods . . . and does them quickly and economically.

The exclusive air-cushioning system built into every Pangborn Vibratory Finishing Machine provides better and closer amplitude control and offers automatic adjustment for any weight load. Air-cushioned floor mounts eliminate any transmitted vibration. No special foundations are necessary. Variable speed controls available on all models. Automated and auxiliary equipment, media, compounds for every need. Send parts with exact finish specifications or finished specimen for sample processing in our laboratory to Mr. William Brandt at:

PANGBORN CORPORATION, 1200 Pangborn Blvd., Hagerstown, Md., Pangborn Canada, Ltd., 47 Shaft Rd., Toronto (Rexdale), Canada; or phone district office in Yellow Pages, "Sand Blast Equipment." *Manufacturers of Vibratory Finishing, Blast Cleaning, Dust and Fume Control Equipment; Rotoblast® Steel Shot and Grit℠.*

Pangborn
OF HAGERSTOWN

BUILD YOUR OWN ENGINEERING LIBRARY
ORDER THE ONES YOU NEED TODAY

Order Them by Mail

MACHINERY'S HANDBOOK—16th Edition

A modern handbook is a necessity for every man who holds or hopes to hold a responsible job in the mechanical industries. This one is the "Bible" of them all. The latest edition of this world-renowned book combines all the valuable features of earlier editions with the most recent and useful machine-designing and machine-shop data obtainable. 192 pages larger than 15th Edition. Over 500 completely new pages of reference data. 2104 Pages, Thumb Indexed.
$13.00

THE USE OF HANDBOOK TABLES AND FORMULAS

A companion book for users of MACHINERY'S HANDBOOK which shows you how to get the most out of your Handbook. Examples, solutions and test questions show typical applications of Handbook matter in both drafting-rooms and machine shops.
$2.00 Special combination price with MACHINERY'S HANDBOOK, $14.50

DIE-CASTING—2nd Edition

by Charles O. Herb

Illustrates and describes the latest die-casting machines. Tables of die-casting alloy composition, the latest developments, discussion of their properties and applications. 196 Illustrations. 310 Pages.
$6.50

MATHEMATICS AT WORK

by Holbrook L. Horton

100 pages of reviews of the fundamentals of arithmetic, algebra, geometry, trigonometry and logarithms. 482 pages of illustrated mechanical problems with step-by-step analyses and solutions. 146 pages of standard mathematical tables needed for all types of problem solving. 196 Illustrations.
$7.50

GEAR DESIGN SIMPLIFIED

New 3rd Edition

by Franklin D. Jones

In chart form. Contains 110 gear-problem charts and worked-out examples of gear design that show exactly how rules are applied in obtaining essential dimensions, angles, or other values. 201 Drawings. 134 Pages. Published Nov. 15, 1961
$6.00

NEW!

INDUSTRIAL ORGANIZATION AND MANAGEMENT FUNDAMENTALS

by H. B. Henderson and A. E. Haas

Here, at last, is a book on management fundamentals for the man aiming for advancement to the management team, or interested in starting or operating his own industrial enterprise. It is a clear, realistic approach to industrial organization and management fundamentals, which gives a concise insight into the various problems faced by management people. Although primarily designed for use in technical institutes and specialized colleges, this book can also be used for home study and in-plant training courses.

One of the outstanding qualities of this book is that it is free of much of the detail and subsidiary technical material which is present in third- or fourth-year college texts. It quickly gets into the "meat" of the subject, and in a clear, readable style presents the basic fundamentals with numerous easy-to-follow charts and diagrams. These diagrams and charts will give you practical pointers on the various methods used for reducing and controlling costs. Others, are used to aid you in getting a better understanding of the principles involved in changing, setting up, or operating an industrial organization. In addition, the information is drawn from many sources so as to be of interest and benefit to those in most manufacturing and productive industries.

All information on these topics is as complete and as up-to-date as possible. 448 Pages, $7.50, 79 Illus.

MACHINE TOOLS—What They Are and How They Work

by Herbert D. Hall and Horace E. Linsley

Introduction to fundamentals of mass production. Covers each machine tool, how and where it functions, skills and organization that make modern mass production possible. A basic, thorough text on all phases of metalworking operations. 363 Illustrations. 488 Pages.
$5.50

DIMENSIONS AND TOLERANCES FOR MASS PRODUCTION

by Earle Buckingham

An analysis of the many problems of dimensioning with tolerances for mass production, showing their effect on tool design, gage design, production and inspection, and suggesting improved methods and practices to solve these problems. 179 Illustrations. 164 Pages.
$9.00

DIE DESIGN AND DIEMAKING PRACTICE

3rd Edition—
by Franklin D. Jones

Drawings and descriptions of a tremendous variety of dies and a vast amount of data to help you avoid expensive mistakes and delays. A standard reference work in the metal working industries, used by some 40,000 diemakers, designers and tool engineers. 661 Illustrations. 1083 Pages.
$11.00

THE NEW PRODUCT

by Delmar W. Karger

It describes in detail how to find ideas, how to test, develop and sell new products. Useful checklists are provided to aid a manager in avoiding common pitfalls and at the same time help him secure the step-by-step success of his project. 21 Charts & Illustrations. 234 Pages.
$5.00

FIRST CLASS
Permit No. 53
New York, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY

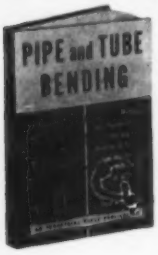
THE INDUSTRIAL PRESS
93 WORTH STREET
NEW YORK 13, N. Y.

BOOK DEPT.

WHICH OF THESE INDUSTRIAL PRESS BOOKS CAN BE MOST VALUABLE TO YOU?

Order Them by Mail

PIPE AND TUBE BENDING



by Paul B. Schubert

Defines the six basic ways by which the bending of ferrous and non-ferrous pipe and tube may be accomplished. Descriptions of methods, applications and features of the equipment available. 159 Illustrations. 183 Pages.

$6.00

MANUAL OF GEAR DESIGN—3 Vols.

by Earle Buckingham

Vol. I: mathematical tables, especially applicable to gear design. Vol II: simple formulas and time-saving tables for solving spur and internal gear designing problems. Vol. III: formulas, charts and tables used in designing and "spiral" gears for non-parallel, non-intersecting shafts.

Complete Three-Volume Set, **$15.00**

Any Single Volume, **$6.00**

HELICAL SPRING TABLES

by John D. Gayer and Paul H. Stone, Jr.

Index of over 6800 ready-designed compression and tension springs from which selections may be made with minimum calculation. 165 Pages.

$6.50

INGENIOUS MECHANISMS FOR DESIGNERS AND INVENTORS

Volumes I and II by Franklin D. Jones
Volume III by Holbrook L. Horton

A comprehensive encyclopedia of mechanical movements unparalleled in scope and usefulness. Each volume is an independent treatise. Similar in size and general character, the contents are different. Tells *what* each mechanism consists of, *how* it operates, and the features which make it of special interest. Hundreds of illustrations.

Single Volume, **$7.50**

Complete Set, **$20.00**

NEW!

BROACHING—TOOLING AND PRACTICE

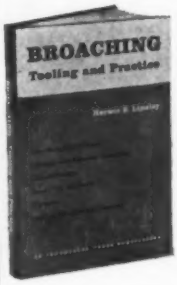
by Horace E. Linsley

In these days of rapidly mounting production costs, the technique of broaching is being ever more widely adopted because of its ability to remove more metal in less time than any other process.

This book covers the entire field of broaching—internal, external, vertical, and horizontal, and explains how each type of machine operates, and for which type of work each is best suited. The design of broaching tools and fixtures is covered in detail, and examples of special and unusual broaching operations are given. The book is well illustrated and also has tables of data for broach ends. This new book will be of great value to manufacturers in the metalworking field who are interested in reducing production costs, as well as to tool and manufacturing engineers responsible for the design of broaching tools and fixtures.

CONTENTS

1. The Broaching Process
Classification — Limitations — Broachability of Materials — Definitions
2. Internal Broaching
Rotary-cut — Double-cut — Blind Hole — Strip — Square Hole — Spline
3. External Broaching
Serrations — Rack and Gear Teeth — Slotting — Curved Surfaces — Rotary Broaching
4. Broach Design
About The Work — About The Machine — About The Broach
5. Broaching Machines
Vertical — Pull-up — Pull-down — Horizontal — Double Ram — Automation — Work Tables
6. Fixtures
Positioning Round Parts — Workpieces Which Do Not Lie Flat — Fixtures for Broaching Helical Splines
7. Setting Up, Trouble Shooting
Broach Stuck In Work — Galling and Pickup — Broach Breakage



224 Pages $6.50
162 Illustrations

ENGINEERING ENCYCLOPEDIA

by Franklin D. Jones

Condensed and practical information on 4500 subjects definitions of numerous terms used in engineering and manufacturing practice, the results of many costly and important tests and experiments. No single work will give you a broader knowledge with less reading effort. 206 Drawings. 1431 Pages.

NOW in ONE Volume, $10.00

MACHINERY'S MATHEMATICAL TABLES

Edited by Holbrook L. Horton

This book has been serving mechanical engineers, machine designers, draftsmen, toolmakers, machinists and students for over 30 years. Now it is available in a greatly enlarged version, containing the authoritative, easy-to-use mathematical tabular information you need on the job. Designed for speed and utility. 254 Pages.

$3.75

MACHINE SHOP TRAINING COURSE

by Franklin D. Jones

Contains 1124 pages of questions and answers, shop problems and solutions, blueprint reading charts. Illustrated by 572 drawings and photographs. For use as a textbook or for designers and production engineers who want the fundamentals of machine shop practice.

Two-Volume Set, **$9.00**

Single Volume, **$5.50**

CHIPLESS MACHINING

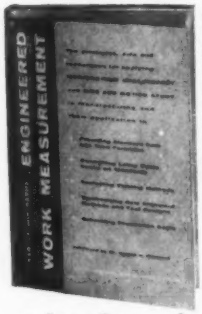
by Charles H. Wick

This is a how-to volume. It describes the essential steps in making parts by various chipless methods. It is a practical guide to the design and selection of machines, tools and accessories. CHIPLESS MACHINING explains the range of various processes, their advantages and limitations—and their typical applications. 502 Pages.

$10.00

ENGINEERED WORK MEASUREMENT

by Delmar W. Karger and Franklin H. Bayha



Comprehensive treatise on solving problems of Methods - Time Measurement (MTM) and Time and Motion Study, to establish efficient procedures. History, fundamentals, mathematics, applications, standards of MTM . . . and complete tables and official MTM working data card are included. 630 pages, 120 illustrations.

$12.00

THE INDUSTRIAL PRESS, 93 Worth Street, New York 13, N. Y.

Please send me the following books.

☐ Bill me ☐ Bill company ☐ Payment enclosed, send books postpaid
Orders from foreign countries, except Canada, must be accompanied by payment in full including 50¢ per book, postage and handling.
☐ Send me complete catalog and details of time payment plan.

. . . . . .

. . . . . .

. . . . . .

NAME . . . . . .

COMPANY . . . . . .

COMPANY ADDRESS . . . . . .

CITY . . . . . ZONE . . . . . STATE . . . . . .

HOME ADDRESS . . . . . .

CITY . . . . . ZONE . . . . . STATE . . . . . .

(please fill in home address only if you want books sent there)

0057

$6.00
Pages. Published
Nov. 15, 1961

CAPEWELL HAS THE RIGHT BANDSAW

for your machine . . . your application . . . your pocketbook

SUPERTECH

Newest Bandsaw cutoff tool developed from a special high speed steel for use on high speed machines. On ferrous metal cutoff work where cost of the blade is subordinate to high performance and accurate cutting, SUPERTECH can surpass ordinary high speed blades by 300%.

TECHNITE®

Premium type high speed steel blades for use on the most powerful and the fastest machines. Excellent for production cutoff work requiring extreme accuracy and speed.

SPEED-BAND®

Double carbide alloy (L-100-M) blade designed and developed by Capewell to permit higher feeds and speeds on carbon band saw machines. Features hot hardness and abrasion resistance. Can be used on a wider range of materials than regular blades.

FLEXIBLE BACK

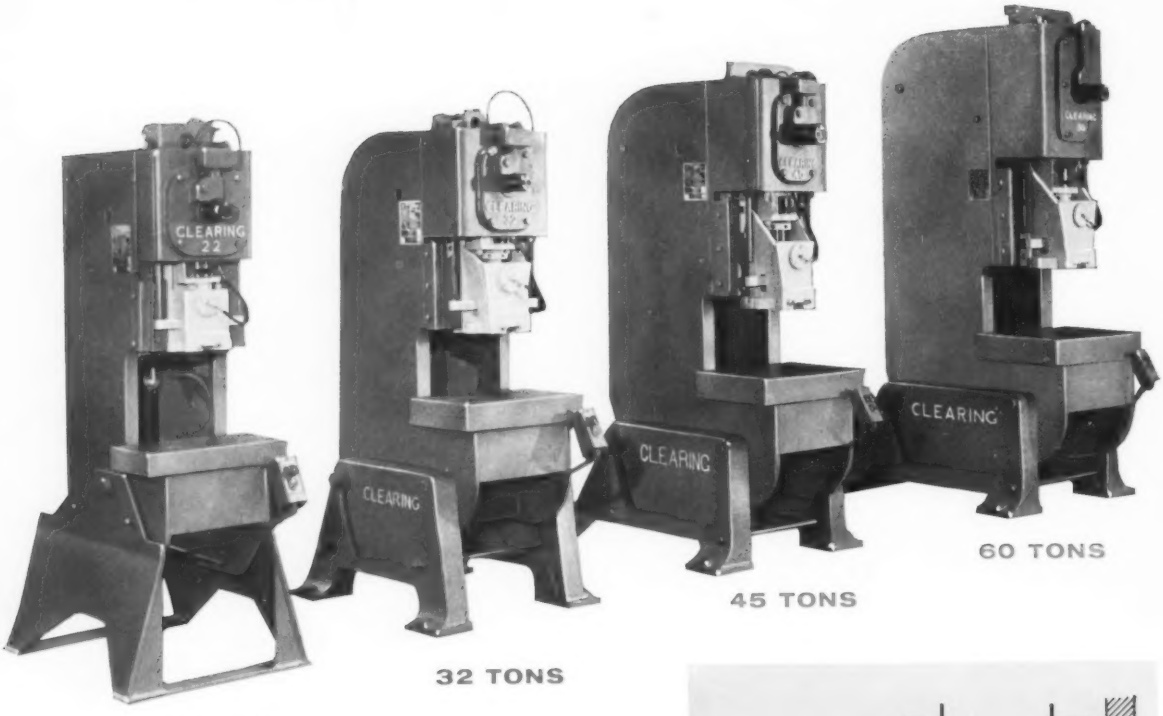
For use on carbon band saw machines. Ideal for cutoff or contour sawing of commonly used metals. Available in raker or wavy set; regular tooth, skip tooth, shark tooth.

CAPEWELL

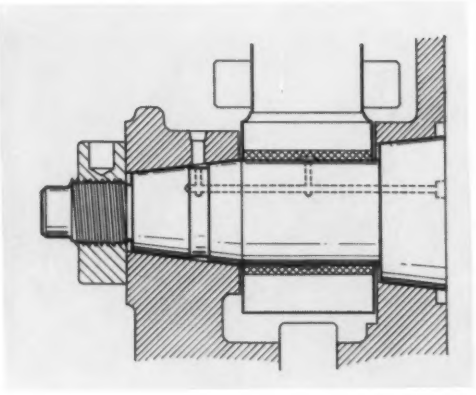
See your Capewell Distributor for Band Saws — Hack Saws — Power Hack Saws — Hole Saws — Hammers —Ground flat stock . . . and all your industrial needs.

INDUSTRIAL DISTRIBUTORS · SERVING INDUSTRY ECONOMICALLY · THE RIGHT HAND OF PRODUCTION

THE CAPEWELL MANUFACTURING CO. HARTFORD 2, CONN.



The Clearelease mechanism makes it possible to unstick the press in a matter of minutes. A taper wrist-pin in the press slide provides instant release. Simply loosen locking nut and tap wrist-pin in.



No Fear of Getting Stuck With a Clearing Torc-Pac

"Sticking" a press is a problem that can send a production manager to the nurse for tranquilizers, as you know. And presses **do** get stuck, let's face it. But here's what Clearing has done about it on the new Torc-Pac line of O.B.I.'s. "Clearelease", an ingenious mechanism built into the press slide makes it possible to unstick the press in a matter of minutes. It's simple and fast and the press is back in operation before tempers can rise.

There are a lot of improvements on the new Torc-Pac. A clutch and brake unit that is as quiet as it is maintenance-free is an important plus. Controls are shock mounted. The streamlined design of Torc-Pac conserves floor space. Feeding is easy from any direction. Find out more about the new Torc-Pac. Ask for literature today.

USI Clearing

DIVISION OF U.S. INDUSTRIES, INC.
6499 W. 65th Street, Chicago 38, Illinois
PO 7-8700